Volume 23 MAY, 1939 Number 5

BULLETIN
of the
American Association *of* Petroleum Geologists

CONTENTS

Travis Peak Formation of Central Texas *By Robert H. Cuyler* 625

Subsurface Study of Greenwich Pool, Sedgwick County, Kansas *By Arnold S. Bunte* 643

New Mathematical and "Stereographic Net" Solutions to Problem of Two Tilts—with Applications to Core Orientation *By Curtis H. Johnson* 663

GEOLOGICAL NOTES

Fairbanks and Satsuma Fields, Harris County, Texas *By C. J. Harvey and W. Z. Burkhead* 686

Oil on Agua Caliente Anticline, Department of Loreto, Peru *By R. G. Greene* 688

Oil Possibilities in Southern Turkey *By Cevat Eyup Tasman* 690

Dora Pool, Seminole County, Oklahoma *By W. I. Ingham* 692

DISCUSSION

Geology of Central Venezuela *By L. Kehrer* 699

REVIEWS AND NEW PUBLICATIONS

Recent Publications 705

THE ASSOCIATION ROUND TABLE

Membership Applications Approved for Publication 707

Association Committees 708

Past and Present Officers of the Association 710

Twenty-Fourth Annual Meeting, Oklahoma City, March 22-24, 1939 711

Minutes, Twenty-Fourth Annual Meeting *By Ira H. Cram* 723

RESEARCH NOTES

Announcement of Research Fund *By A. I. Levorsen* 757

Research Problems *By A. I. Levorsen* 757

AT HOME AND ABROAD

Current News and Personal Items of the Profession 758

Copyright, 1939, by The American Association of Petroleum Geologists, Inc.

CABLE TOOL OPERATORS:

WHEN YOU WANT TO KNOW FACTS ABOUT FORMATIONS PENETRATED—SUCH AS

POROSITY • PERMEABILITY SATURATION • GRAIN SIZE COMPOSITION

HERE ARE THE TYPES OF CORES THAT WILL GIVE YOU THAT INFORMATION.

THEY ARE BAKER CORES RECOVERED WITH A BAKER CABLE TOOL CORE BARREL.

It will pay you to investigate this efficient, economical, easily operated device. Full details are given in the Baker Section of your 1939 Composite Catalog.

BAKER OIL TOOLS, INC.

Telephone JEfferson 8211 – HUNTINGTON PARK, CALIFORNIA – 2959 E. Slauson Ave.
Telephone WAyside 2108 – HOUSTON PLANT AND OFFICE – 6023 Navigation Blvd.

MID-CONTINENT OFFICE AND WAREHOUSE:
Telephone 2-8083 – Tulsa, Oklahoma – 312 East Fourth Street

WEST TEXAS BRANCH OFFICE
Odessa, Texas – Telephone 217

EXPORT SALES OFFICE
Rm. 1914 – 19 Rector St., New York City
Tel. Digby 4-5515

ROCKY MOUNTAIN HEADQUARTERS
Tel. 2230, Casper, Wyoming – Box 1468

BAKER CABLE TOOL CORE BARREL

BULLETIN

of the

AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

OFFICE OF PUBLICATION, 608 WRIGHT BUILDING, TULSA, OKLAHOMA

WALTER A. VER WIEBE, *Editor*

GEOLOGICAL DEPARTMENT, UNIVERSITY OF WICHITA, WICHITA, KANSAS

ASSOCIATE EDITORS

GENERAL	K. C. HEALD, Gulf Oil Corporation, Box 1166, Pittsburgh, Pa. HUGH D. MISER, U. S. Geological Survey, Washington, D. C. THERON WASSON, Room 2308, 35 E. Wacker Drive, Chicago, Ill.
APPALACHIANS	
North	JOHN R. REEVES, Penn-York Natural Gas Corporation, Buffalo, N.Y.
South	WILLIAM O. ZIEBOLD, 1572 Virginia Street, Charleston, W. Va.
NORTH CENTRAL STATES	R. B. NEWCOMBE, 303 South Main Street, Mount Pleasant, Mich.
KANSAS	ANTHONY FOLGER, Gulf Oil Corporation, Wichita, Kan.
OKLAHOMA	
Western	ROBERT H. DOTT, Oklahoma Geological Survey, Norman, Okla.
Eastern	SHERWOOD BUCKSTAFF, Shell Oil Company, Inc., Box 1191, Tulsa, Okla.
TEXAS	
North and Central	J. B. LOVEJOY, Gulf Oil Corporation, Fort Worth, Tex.
Northeastern	E. A. WENDLANDT, Humble Oil and Refining Company, Tyler, Tex.
San Antonio	HERSCHEL H. COOPER, 1015 Milam Building, San Antonio, Tex.
Permian Basin	HAL P. BYBEE, Box 2101, University Station, Austin, Tex.
GULF COAST	SIDNEY A. JUDSON, Texas Gulf Producing Company, Houston, Tex. MARCUS A. HANNA, Gulf Oil Corporation, Houston, Tex.
ARKANSAS AND NORTH LOUISIANA	ROY T. HAZZARD, Gulf Refining Company of Louisiana, Shreveport, La.
ROCKY MOUNTAINS	A. E. BRAINERD, Continental Oil Company, Denver, Colo.
CALIFORNIA	W. S. W. KEW, Standard Oil Company, Los Angeles, Calif. W. D. KLEINPELL, Box 1131, Bakersfield, Calif.
FOREIGN	
General	MARGARET C. COBB, Room 2703, 120 Broadway, New York, N. Y.
Europe	W. A. J. M. VAN WATERSCHOOT VAN DER GRACHT, Staatstoezicht op de Mijnen, Heerlen, Holland
Canada	THEODORE A. LINK, Imperial Oil, Ltd., Calgary, Alberta
South America	HOLLIS D. HEDBERG Mene Grande Oil Co., Apt. 35, Ciudad Bolivar, Venezuela

THE BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS is published by the Association on the 15th of each month. Editorial and publication office, 608 Wright Building, Tulsa, Oklahoma. Post Office Box 979. Cable address, AAPGEOL.

THE SUBSCRIPTION PRICE to non-members of the Association is $15.00 per year (separate numbers, $1.50) prepaid to addresses in the United States. For addresses outside the United States, an additional charge of $0.40 is made on each subscription to cover extra wrapping and handling.

British agent: Thomas Murby & Co., 1 Fleet Lane, Ludgate Circus, London, E. C. 4.

German agent: Max Weg, Inselstrasse 20, Leipzig CI, Germany.

CLAIMS FOR NON-RECEIPT of preceding numbers of THE BULLETIN must be sent Association headquarters within three months of the date of publication in order to be filled gratis.

BACK NUMBERS OF THE BULLETIN, as available, can be ordered from Association headquarters. Paper-bound Vol. 2 (1918), $4.00; Vol. 3 (1919), $5.00. Cloth-bound Vol. 5 (1921), $12.00; Vols. 11 (1927) to 16 (1932), Vol. 22 (1938), each $17.00. Other volumes, many separate numbers, and a few nearly complete sets are available. Descriptive price list sent on request. Special prices to members and associates. Discounts to libraries. *Structure of Typical American Oil Fields*, Vol. II (1929), $7.00 ($5.00 to members and associates). *Stratigraphy of Plains of Southern Alberta* (1931), $1.50. *Geology of Natural Gas* (1935), $6.00 ($4.50 to members and associates). *Geology of Tampico Region, Mexico* (1936), $4.50 ($3.50 to members and associates). *Structural Evolution of Southern California* (1936), $2.00. *Gulf Coast Oil Fields* (1936), $4.00 ($3.00 to members and associates). *Comprehensive Index, 1917–1936* (1937), $3.00 (to members and associates: free; extra copy, $2.00). *Miocene Stratigraphy of California* (1938), $5.00 ($4.50 to members and associates).

THE BULLETIN furnishes thirty-five reprints of major papers. Additional reprints and covers for all or part are furnished at cost. ORDERS FOR REPRINTS should accompany corrected galley proof.

Association Headquarters—608 Wright Building, 115 and 117 West Third Street, Tulsa, Oklahoma.

Communications about the Bulletin, manuscripts, editorial matters, subscriptions, special rates to public and university libraries, publications, membership, change of address, advertising rates, and other Association business should be addressed to

THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS, INC.

BOX 979

TULSA, OKLAHOMA

Entered as second-class matter at the Post Office at Tulsa, Oklahoma, and at the Post Office at Menasha, Wisconsin, under the Act of March 3, 1879. Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized March 9, 1923.

THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS, INC.

(Organized at Tulsa, Oklahoma, February 10, 1917, as the Southwestern Association of Petroleum Geologists. Present name adopted, February 16, 1918. Incorporated in Colorado, April 23, 1924. Domesticated in Oklahoma, February 9, 1925.)

OFFICERS FOR THE YEAR ENDING MARCH, 1940

HENRY A. LEY, *President*, San Antonio, Texas
L. MURRAY NEUMANN, *Vice-President*, Tulsa, Oklahoma
EDGAR W. OWEN, *Secretary-Treasurer*, San Antonio, Texas
WALTER A. VER WIEBE, *Editor*, Wichita, Kansas

(The foregoing officers, together with the *Past-President*, DONALD C. BARTON, Houston, Texas, constitute the Executive Committee.)

DISTRICT REPRESENTATIVES

(Representatives terms expire immediately after annual meetings of the years shown in parentheses)

Amarillo: Carl C. Anderson (40), Amarillo, Tex.
Appalachian: Paul H. Price (41), Morgantown, W. Va.
Canada: Harry M. Hunter (41), Calgary, Canada
Capital: Arthur A. Baker (40), Washington, D. C.
Dallas: P. W. McFarland (40), Dallas, Tex.
East Oklahoma: W. B. Wilson (40), N. W. Bass (41), Robert H. Wood (41), Tulsa, Okla.
Fort Worth: Charles E. Yager (41), Fort Worth, Tex.
Great Lakes: A. H. Bell (41), Urbana, Ill.
Houston: Wallace C. Thompson (40), J. Boyd Best (41), Lon D. Cartwright, Jr. (41), Houston, Tex.
Mexico: William A. Baker, Jr. (39), Houston, Tex.
New Mexico: Harold S. Cave (39), Roswell, N. Mex.
New York: W. T. Thom, Jr. (41), Princeton, N. J.
Pacific Coast: E. J. Bartosh (40), Harold K. Armstrong (41), Herschel L. Driver (41), Los Angeles, Calif.
Rocky Mountains: C. E. Dobbin (41), Denver, Colo.
Shreveport: C. L. Moody (41), Shreveport, La.
South America: G. Moses Knebel (41), Caripito, Venezuela
So. Permian Basin: Ronald K. De Ford (41), Midland, Tex.
South Texas: C. C. Miller (41), Corpus Christi; Harry H. Nowlan (41) San Antonio, Tex.
Tyler: Edward B. Wilson (41), Tyler, Tex.
West Oklahoma: C. W. Tomlinson (41), Ardmore, Okla.
Wichita: James I. Daniels (41), Wichita, Kan.
Wichita Falls: Virgil Pettigrew (40), Wichita Falls, Tex.

DIVISION REPRESENTATIVES

Paleontology and Mineralogy

Gayle Scott (40), Fort Worth, Tex.
Henryk B. Stenzel (40), Austin, Tex.

PACIFIC SECTION (Chartered, March, 1925)

ROY M. BARNES, *President*, Continental Oil Company, Los Angeles, California
H. D. HOBSON, *Secretary-Treasurer*, Continental Oil Company, Los Angeles, California

Membership restricted to members of the Association in good standing, residing in Pacific Coast states. Dues: $1.50 per year.

SOUTH TEXAS SECTION (Chartered, April, 1929)

WILLIS STORM, *President*, 1733 Milam Building, San Antonio, Texas
IRA A. BRINKERHOFF, *Secretary-Treasurer*, Stanolind Oil and Gas Company, San Antonio, Texas

Membership limited to persons eligible to Association membership. Dues: $2.50. Annual meeting in October.

MARACAIBO SECTION (Chartered, April, 1930)

JOHN G. DOUGLAS, *President*, Mene Grande Oil Company, Apartado, 234 Maracaibo, Venezuela

DIVISION OF PALEONTOLOGY AND MINERALOGY
SOCIETY OF ECONOMIC PALEONTOLOGISTS AND MINERALOGISTS

(Organized, March, 1927; affiliated, March, 1928; chartered, technical division, April, 1930)

GAYLE SCOTT, *President*, Fort Worth, Texas
HENRYK B. STENZEL, *Secretary-Treasurer*, Bureau of Economic Geology, Austin, Texas

SEND DUES, SUBSCRIPTIONS, AND ORDERS FOR BACK NUMBERS TO BOX 979, TULSA ,OKLAHOMA.

The Society and the Paleontological Society jointly issue six times a year the *Journal of Paleontology*, Norman D. Newell, University of Wisconsin, Madison, Wisconsin, and C. Wythe Cooke, U. S. Geological Survey, Washington, D. C., editors: subscription, $6.00. The *Journal of Sedimentary Petrology*, W. H. Twenhofel, editor, University of Wisconsin, Madison, Wisconsin, is issued three times a year: subscription, $3.00. Single copies, *Journal of Paleontology*, $2.00; *Journal of Sedimentary Petrology*, $1.50. Society dues: with *Jour. Pal.*, $6.00; with *Jour. Sed. Petrology*, $3.00; with both, $8.00 per year.

AFFILIATED SOCIETIES

(Dates of affiliation in parentheses)

Alberta Society of Petroleum Geologists, Calgary, Alberta, Can. (31). R. G. Paterson, Secy., 215 Sixth Avenue, West
Appalachian Geological Society, Charleston, W. Virginia (31). Charles Brewer, Jr., Secy., Godfrey L. Cabot, Inc., Box 348
Ardmore Geological Society, Ardmore, Oklahoma (36). W. Morris Guthrey, Secy., The Texas Company
Dallas Petroleum Geologists, Dallas, Texas (35). Henry J. Morgan, Jr., Secy., Atlantic Refining Company
East Texas Geological Society, Tyler, Texas (32). F. J. Schempf, Secy., Stanolind Oil and Gas Company
Fort Worth Geological Society, Fort Worth, Texas (31). Vernon Lipscomb, Secy., The Pure Oil Company
Houston Geological Society, Houston, Texas (32). Carleton D. Speed, Jr., Secy., Speed Oil Company
Illinois Geological Society (39). Elmer W. Ellsworth, Secy., W. C. McBride, Inc., Centralia, Illinois
Kansas Geological Society, Wichita, Kansas (31). E. Gail Carpenter, Secy., consulting geologist
Michigan Geological Society, Lansing, Mich. (37). R. P. Grant, Secy., Michigan Geological Survey
North Texas Geological Society, Wichita Falls, Texas (38). Orion A. Daniel, Secy., 814 Hamilton Building
Oklahoma City Geological Society, Oklahoma City, Oklahoma (31). R. Hancock, Secy., Magnolia Petroleum Company
Panhandle Geological Society, Amarillo, Texas (32). G. R. Carter, Secy., Gulf Oil Corporation
Shawnee Geological Society, Shawnee, Oklahoma (31). Tom M. Girdler, Jr., Secy., Sinclair Prairie Oil Company
Shreveport Geological Society, Shreveport, Louisiana (32). E. F. Miller ,Secy., Bay Oil Corporation, 911 Commercial Bank
Society of Exploration Geophysicists, Houston, Tex. (32). John H. Crowell, Secy., 2011 Esperson Building
South Louisiana Geological Society, Lake Charles, La. (37). W. R. Canada, Secy., 207 Weber Building
Southwestern Geological Society, Austin, Texas (37). W. C. Ikins, Secy., Department of Geology, University of Texas
Tulsa Geological Society, Tulsa, Oklahoma (31). M. H. Brown, Secy., Darby Petroleum Corporation, Philtower Building
Western Kentucky Geological Society, Owensboro, Kentucky (38). R. E. Knipe, Secy., The Ohio Oil Company
West Texas Geological Society, Midland, Texas (38). J. E. Simmons, Secy., Continental Oil Company

Finer Seismograph Recordings

under severe summer conditions

Improved Haloid Record retains its exceptional original qualities under severest tests of extreme heat and humidity. Uniformly dependable, it gives you exceptional contrast under all conditions. Whites sparkle sharply against deep blacks. Development is fast, manipulation easy. Wide latitude in exposure and development speed up work, cut waste. Curl and sheen are reduced to a minimum. It will pay you to try Improved Haloid Record this summer.

Protected From Heat, Humidity, Dust, Dirt, & Light

Improved Haloid Record, packed in new hermetically sealed cans, helps you hurdle these five barriers to fine recordings. That's why you can depend on Improved Haloid Record for top performance this summer.

Sample cans sent on request. Specify regular size . . . Maximum, *in cans*, 8″ x 200′.

THE HALOID COMPANY • 293 Haloid St. • Rochester, N.Y.

HALOID RECORD

For Superior Geophysical Recordings

SPECIAL PUBLICATIONS

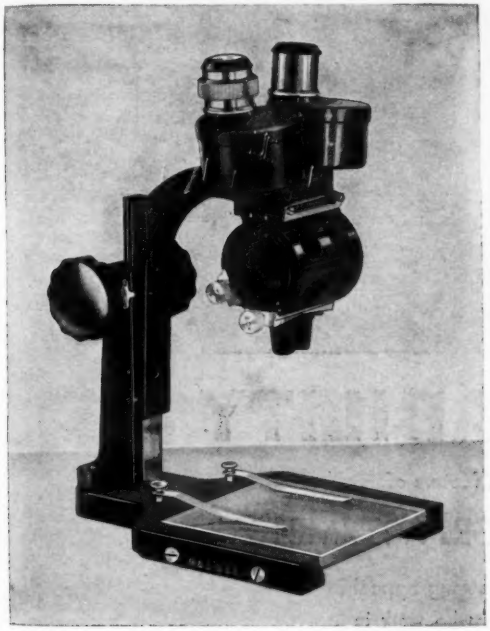
THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

Box 979, Tulsa, Oklahoma

1929	**Structure of Typical American Oil Fields.** Symposium on relation of oil accumulation to structure. By many authors. Originally in 2 volumes. Vol. I, exhausted. Vol. II, 780 pp., 235 illus. 6 x 9 inches. Cloth. **To members and associates, Vol. II, $5.00** ..... **Vol. II**	**$ 7.00**
1935	**Geology of Natural Gas.** Symposium on occurrence and geology of natural gas in North America. By many authors, 1,227 pp., 250 illus. 6 x 9 inches. Cloth. **To members and associates, $4.50**	**6.00**
1936	**Geology of the Tampico Region, Mexico.** By John M. Muir. 280 pp., 15 half-tone plates, 41 line drawings, 9 tables. 6 x 9 inches. Cloth. **To members and associates, $3.50**	**4.50**
1936	**Gulf Coast Oil Fields.** Symposium on Gulf Coast Cenozoic. By 52 authors. Chiefly papers reprinted from the Association *Bulletin* of 1933-1936 gathered into one book. xxii and 1,070 pp., 292 figs., 19 half-tone pls. 6 x 9 inches. Cloth. **To members and associates, $3.00**	**4.00**
1936	**Structural Evolution of Southern California.** Sequel to **Geology of California.** By R. D. Reed and J. S. Hollister. 158 pp., 8 half-tone plates, 57 line drawings, 6 tables, 1 folded map in colors. Reprinted from December, 1936, *Bulletin*, bound in cloth. 6 x 9 inches	**2.00**
	Areal and Tectonic Map of Southern California, in colors, same as in book, 27 x 31 inches, rolled in mailing tube	**.50**
1937	**Comprehensive Index** of 20 volumes of the *Bulletin* and all special publications of the Association (1917-1936). By Daisy Winifred Heath. 382 pp., 6.75 x 9.5 inches. Paper. **To paid up members and associates, one copy free**	**3.00**
1938	**Miocene Stratigraphy of California.** By Robert M. Kleinpell. 450 pp.; 14 line drawings, including a large correlation chart; 22 full-tone plates of foraminifera; 18 tables (check lists and a range chart of 15 pages). 6 x 9 inches. Cloth. **To members and associates, $4.50**	**5.00**

Prices postpaid. Write for discount to colleges and public libraries.

In Oklahoma, add 2 per cent for sales tax.



STEREOSCOPIC MAGNIFICATION

WITH

The B&L Wide Field Microscope

THE three dimensional, erect, unreversed image obtained with the B&L Wide Field Binocular Microscope greatly facilitates the examination and identification of specimens. Long working distance, wide field of view, 7 to 150X magnification are other features of this instrument.

Whether you use it in the field or laboratory, this microscope with its rugged construction will give you lasting accuracy. A substantial carrying case suitable for field use is included.

For complete details write to Bausch & Lomb Optical Co., 610 St. Paul Street, Rochester, New York

B&L Wide Field Binocular Microscope AKW, illustrated, may be placed directly upon any part of a large specimen. For smaller objects a clear glass stage 100 x 100 mm is supplied.

BAUSCH & LOMB

FOR YOUR EYES, INSIST ON BAUSCH & LOMB EYEWEAR, MADE FROM BAUSCH & LOMB GLASS TO BAUSCH & LOMB HIGH STANDARDS OF PRECISION

★ ★

PORTABILITY

is a feature of

ASKANIA GRAVITYMETERS

with a strong appeal
to men who work in

inaccessible areas

With various technical features which appeal strongly to the geophysicist, the portability of the Askania Gravitymeter has made it an outstanding favorite for rapid work.

When the area to be surveyed becomes impassable for the truck on which the instrument normally is mounted, it can be changed to portable equipment, as illustrated, in a brief 10 minutes.

Write for literature describing the Askania Gravitymeter and typical surveys. Address,

ASKANIA

AMERICAN ASKANIA CORP.

826 M & M BUILDING, HOUSTON, TEXAS

Bulletin Advertisers

American Askania Corporation vi
American Paulin System .....
Baker Oil Tools, Inc. .....Inside front cover
Baroid Sales Department xxiv
Barret, William M., Inc. xviii
Bausch and Lomb v
Borntraeger Brothers xxii
Dowell Incorporated viii
Eastman Kodak Stores, Inc. xvii
Eastman Oil Well Survey Company .....
Economic Geology Publishing Company ..xvii
Failing Supply Company .....
First Natl. Bank and Trust Co. of Tulsa....xxii
Geophysical Service, Inc. ....Inside back cover
Geotechnical Corporation xxii
Gulf Publishing Company xx
Haloid Company iii
Hughes Tool Company ....Outside back cover
Illinois Powder Manufacturing Company ..xvii
Independent Exploration Company xix
International Geophysics, Inc. xxv
Journal of Geology xvii
Journal of Paleontology .....
Journal of Sedimentary Petrology .....
Lane-Wells Company xxi
Leitz, E., Inc. xxiv
Reed Roller Bit Company .....
Revue de Géologie xvii
Schlumberger Electrical Prospecting Methods .....xxx-xxxi
Schlumberger Well Surveying Corp. xxviii
Seismic Explorations, Inc. .....
Seismograph Service Corporation .....
Spencer Lens xxix
Sperry-Sun Well Survey Company .....
Subterrex xxvi
Sullivan Machinery Company .....
Triangle Blue Print and Supply Company..xvii
United Geophysical Company xxiii
Western Geophysical Company xxiii

PROFESSIONAL CARDS

Joseph L. Adler xii
William M. Barret x
Donald C. Barton xii
Elfred Beck xi
Brokaw, Dixon & McKee ..x
William F. Brown x
D'Arcy M. Cashin xii
Frederick G. Clapp x
Willard J. Classen ix
Richard R. Crandall ix
Cummins & Berger xiii
Ronald K. DeFord x
E. DeGolyer xii
Alexander Deussen xii
David Donoghue xii
Robert H. Durward xiii
J. E. Eaton ix
R. H. Fash xii
A. H. Garner xi
R. L. Ginter xi
Paul P. Goudkoff ix
C. A. Heiland x
Malvin G. Hoffman xi
Holl and Oborne x
Hudnall & Pirtle xiii
Huntley & Huntley xi
John S. Ivy xiii
W. P. Jenny xii
Vernon L. King ix
H. Klaus .....xi, xii
R. W. Laughlin xi
Marvin Lee x
A. I. Levorsen xi
George C. Matson xii
Geo. C. McGhee xii
Wm. C. McGlothlin xiii
Chas. Gill Morgan ix
L. C. Morgan x
R. H. Palmer x
Dabney E. Petty xiii
David B. Reger xiii
John L. Rich xi
Frank C. Roper xiii
E. E. Rosaire xiii
W. G. Saville xiii
J. P. Schumacher xiii
A. T. Schwennesen xiii
R. W. Sherman ix
Walter Stalder ix
R. L. Triplett ix
Harold Vance xiii
G. H. Westby xii

GEOLOGICAL AND GEOPHYSICAL SOCIETIES

Appalachian xvi
Ardmore xv
Dallas xv
East Texas xv
Exploration Geophysicists .xvi
Fort Worth xvi
Houston xvi
Kansas xiv
Michigan xiv
North Texas xvi
Oklahoma City xvi
Rocky Mountain xiv
Shawnee xv
Shreveport xiv
South Louisiana xiv
South Texas xvi
Southwestern xvi
Stratigraphic xv
Tulsa xv
West Texas xvi

Articles for June *Bulletin*

Relation between Crude Oil and Product Prices
By Sidney Swensrud
Wildcat Drilling in 1938
By Frederic H. Lahee
Wildcat Activity in Kansas, 1938
By Edward A. Koester
Developments in Kansas in 1938
By Rycroft G. Moss
Recent Developments in Illinois, with Special Reference to Formations below the McClosky
By Alfred H. Bell and George V. Cohee
Developments in Oklahoma during 1938
By E. F. Shea
Developments in West Texas and Southeastern New Mexico during 1938
By H. P. Bybee, Berte R. Haigh, and Surce John Taylor
North-Central Texas Developments, 1938
By J. J. Maucini
Developments in South Texas, 1938-1939
By Gentry Kidd
Review of Developments in 1938, Gulf Coast of Southeast Texas and Louisiana
By O. L. Brace
Development in East Texas during 1938
By E. A. Wendlandt and G. W. Pirtle
Developments in North Louisiana-South Arkansas, 1938
By W. C. Spooner
Developments in Rocky Mountain Region in 1938
By J. M. Kirby and H. N. Hickey
Additions to Oil Reserves in California during 1938
By Harold W. Hoots
Foreign Developments during 1938
By Basil B. Zavoico

Look to
DOWELL
OIL AND GAS WELL CHEMICAL SERVICE

For Service

Dowell maintains a number of specially designed and fully equipped traveling laboratories. These Dowell "field units" are available for the use of the operator. They are typical of the many oil and gas well chemical services pioneered and perfected by Dowell during the past seven years.

Dowell engineers know how to diagnose a well properly. They know how to determine from that diagnosis the proper treatment for that well.

Dowell treaters are technically trained men who have passed through a thorough training period of several years. This expert knowledge together with the finest equipment available renders service that gets results for the producer.

DOWELL INCORPORATED
GENERAL OFFICE:
KENNEDY BUILDING, TULSA, OKLAHOMA
Subsidiary of
THE DOW CHEMICAL COMPANY

OIL AND GAS WELL CHEMICAL SERVICE

Volume 23 Number 5

BULLETIN
of the
AMERICAN ASSOCIATION OF
PETROLEUM GEOLOGISTS

MAY, 1939

TRAVIS PEAK FORMATION OF CENTRAL TEXAS[1]

ROBERT H. CUYLER[2]
Austin, Texas

ABSTRACT

The Travis Peak formation and its members were named and described by Hill in 1889. At the type locality in Travis County, the formation consists of the Sycamore sands and conglomerates, composing the lowest member, the Cow Creek limestones and shell beds forming the middle member, and the Hensell sands and marls comprising the upper member. The Travis Peak thickens in the subsurface east, south, and southwest of the type locality. With the exception of the basal conglomerates, the beds of the Travis Peak are uniform throughout the exposures. The fossiliferous Cow Creek is the most persistent of the three members.

INTRODUCTION

Data for this paper are based on work done between 1927 and 1937. During this time, incident to deeper drilling, the Travis Peak formation has become more important commercially. It is questionable whether various beds assigned to Travis Peak age in different areas are named correctly; therefore, a detailed study of the surface section of the formation at the type locality is necessary in order to be certain of correlations.

In this paper only data primarily concerned with surface outcrops in Burnet, Williamson, Travis, Blanco, Hays, and Comal counties are given. Subsurface data, correlations, cross sections, and maps are included in another paper to be presented later.

The writer is indebted particularly to F. L. Whitney of The University of Texas for the use of his collections and for his suggestions, to F. M. Bullard, of The University of Texas for his criticisms, and to V. A. Brill for the use of a manuscript which he prepared on the Travis Peak, and for the Travis Peak fossils which he left with The University of Texas.

[1] Read before the Association at New Orleans, March 18, 1938. Revised manuscript received, January 17, 1939.

[2] Department of Geology, The University of Texas.

The Travis Peak formation and its members were named by Robert T. Hill[3] in 1889 because of the excellent exposures in the vicinity of the Travis Peak Post Office, Travis County, Texas. At that locality, according to Taff,[4] the formation has a thickness of 263 feet. The writer has checked this on Hickory Creek; however, he finds that the formation increases in thickness toward the east, south, and southwest. Since the Travis Peak was originally described, many references have been made to it in the literature. Hill contributed the majority of these; but Taff, Cragin, Burckhardt, and others have also made their contributions to our knowledge of the formation.

The Travis Peak is the lowest formation in the Trinity group in central Texas. Table I illustrates the relative position of the Trinity with respect to other groups of the Cretaceous.

TABLE I

GENERALIZED SECTION OF CRETACEOUS IN CENTRAL TEXAS

Period	*Series*	*Group*	*Formation*
Cretaceous	Gulf	Navarro	Kemp Corsicana Nacatoch Neylandville
			Taylor Austin Eagle Ford
		Washita	Buda Del Rio Georgetown
	Comanche	Fredericksburg	Edwards Comanche Peak Walnut
		Trinity	Glen Rose Travis Peak

Outcrops of rocks in the Trinity group may be traced from Mexico across Texas to the Arbuckle Mountains in Oklahoma. In southern Texas, the group is represented by the Glen Rose formation and underlying limestones and sands. On the outcrop, there is a gradual change from south to north, the Trinity being represented in the south by sediments calcareous in nature, for the most part, and in the north by sands almost exclusively. In central Texas, the group is represented by the Travis Peak and Glen Rose. Toward the north and west, the Paluxy sands become more important as part of the

[3] R. T. Hill, "Cretaceous Rocks of Texas and Their Economic Uses," *1st Ann. Rept. Geol. Survey of Texas* (1890), p. 118.

[4] J. A. Taff, "The Cretaceous Area North of the Colorado River," *3rd Ann. Rept. Geol. Survey of Texas* (1892), p. 295.

Trinity group at the expense of the Glen Rose. The lower parts of the Trinity thin within short distances toward the north. Along Red River, in the extreme northern part of the state, the Trinity group is represented entirely by the Antler sands.

The term "Basement sands" is generally used to designate the lowest sands of the Cretaceous. This is confusing because not all these beds are of the same age in different localities. Then, too, the lowest Cretaceous beds on the outcrop are not the lowest in subsurface. This formation is better developed in the subsurface northeast, east, south, and southwest of the type locality. This condition would be expected inasmuch as the main catchment basin formed by the Travis Peak sea lay in those directions.

Due to the overlap caused by the advance of the Trinity sea, the "Basement sands" are different in age in various localities. Local names are given to series of strata in areas where sufficient lithologic changes have taken place to show diverse characteristics. Travis Peak is one of these local terms and is considered equivalent to the European Upper Aptian. Paleontologic criteria for this correlation are fairly conclusive, but are not presented here. The writer has described 56 species of macroscopic fossils from the Travis Peak, 30 of these new; however, these are not included in this paper. The microfauna has not been worked in detail, although microfossils have been observed in both the Cow Creek and Hensell members.

TOPOGRAPHY

The Travis Peak formation weathers into two distinct types of topography. The Cow Creek beds, which are consolidated and hard in nature, form a roughly dissected surface; whereas, the Sycamore and Hensell sands, which are characteristically soft, form a relatively smooth surface and a gently rolling topography.

Wherever the Cow Creek beds crop out, the region is generally rough and hilly. Numerous valleys cut in these beds are in the form of canyons with steep walls on each side, forming sheer bluffs. Examples of such topography may be observed along Pedernales River at Hammett's Crossing, Cox's Crossing, or anywhere along the river between these places. Another topographic feature peculiar to the Travis Peak is the presence of large, crescent-shaped holes. These occur along the courses of small streams, and are formed because of differences in the rate of weathering of the Cow Creek beds and the softer strata which lie directly beneath. The more rapid weathering of the Sycamore sands beneath the Cow Creek limestones causes the heavier beds to be undercut. The result of such action is the formation of

semi-circular holes, as a rule 50–200 feet in diameter and 40–50 feet deep. Generally a waterfall is present, also, the fall being developed over the Cow Creek strata. Dead Man's Hole, Hamilton Pool, West Cave, and Curiosity Cavern are among the striking examples of this type of topographic feature common to the Travis Peak formation.

STRATIGRAPHY

The Travis Peak formation of central Texas consists primarily of conglomerates, sands, and bluish shales in the lower part; limestones in the middle; and calcareous sandstones, marl, arenaceous limestone, and bands of conglomerate in the upper part. The relationship of these members in various localities is shown in Figure 1.

Deposition of Travis Peak sediments east of the Llano uplift was fairly uniform. The thickness of the formation varies according to the locality although the general nature of the various phases in the different localities is the same. At the surface everywhere, conglomerate is present at the base of the Travis Peak, as well as the Cow Creek beds or their equivalents, and the red sands and sandy limestones above the Cow Creek beds. In this respect, the similarity of sections in different regions is notable.

In northern Burnet County, the Travis Peak is entirely missing, the Walnut formation resting unconformably on the underlying Paleozoic rocks. In central Burnet County, the Travis Peak is less than 50 feet in thickness. Southeast of Burnet County, the formation thickens decidedly, and at Austin is represented by approximately 500 feet of sediments, recorded in the log of a well drilled at the State Hospital for the Insane.

Toward the southeast on the surface, the Travis Peak maintains approximately the same thickness as at the type locality in northwestern Travis County, the sandy members becoming thinner and the limestone phase thicker. At Cox's Crossing, the total thickness of the beds assigned to the Travis Peak is approximately 260 feet, as compared with 263 feet at its type locality.

At Hammett's Crossing of Pedernales River, about 7 miles airline up the river from Cox's Crossing, only sediments above the basal conglomerate crop out. The total thickness of Travis Peak strata exposed in this immediate area is 217 feet. In an airline of about 2 miles in a southerly direction from Hammett's Crossing, a complete section of Travis Peak is exposed in the vicinity of Dead Man's Hole where the total thickness of the formation is 209 feet.

On Rebecca Creek, in western Comal County, the limestones of the middle Travis Peak and the sands of the upper part have a total

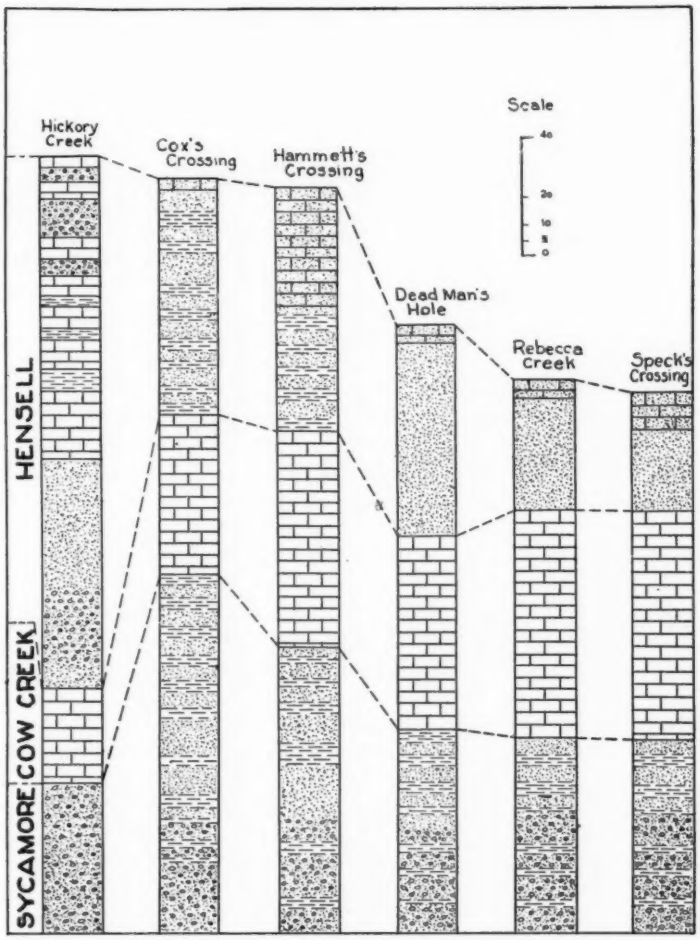


FIG. 1.—Correlation of surface sections of Travis Peak.

thickness of 120 feet. Strata below these limestones are not exposed at this locality.

At Speck's Crossing, Comal County, again, only the middle and upper parts of the Travis Peak are exposed, the total thickness of these members being 118 feet. The clays, sands, and conglomerates below the limestones are not in evidence here.

TABLE II

THICKNESS (IN FEET) OF MEMBERS OF TRAVIS PEAK AT SURFACE

Member	*Lithologic Character*	*Hickory Creek*	*Cox's Crossing*	*Hammett's Crossing*	*Dead Man's Hole*	*Rebecca Creek*	*Speck's Crossing*
Hensell	Conglomerate, sandstone, sandy limestone, and sandy shale	40	80*	79	72	45	40
	Sand	143					
Cow Creek	Limestone and shell beds	30	56*	76*	65	75	78
Sycamore	Marl and sand	50	93*	62*	30	Not exposed	Not exposed
	Basal conglomerate		Mostly covered	Covered	42	Not exposed.	Not exposed
	Total thickness exposed	263 Complete section	229 Exposed	217 Exposed	209 Complete section	120 Exposed	118 Exposed

* Aneroid barometer measurements.

Hill has assigned the Cretaceous sediments under the Glen Rose in the Fredericksburg region to the Gillespie formation. In that locality, these beds have a total thickness of about 175 feet. West and northwest of this area, the members of the Trinity group gradually become thinner, until finally in northern Burnet County, the Cretaceous-Pennsylvanian contact is between formations of the Fredericksburg group and the Pennsylvanian.

Table II is included here for convenience in comparing variations in thickness of members of the formation according to localities.

SYCAMORE MEMBER

The Sycamore member, named by Hill,[5] consists primarily of sands and conglomerates which are stratigraphically below the limestones in the middle part of the Travis Peak formation. Some confusion exists regarding the usage of Hill's Sycamore sand in the Cretaceous of Texas and Taff's Sycamore limestone in the Mississippian of Oklahoma. Hill's term has prior usage and is therefore used here as the valid name of a member of the Travis Peak.

It is to be concluded, after making a study of the conditions under which the Travis Peak was deposited, that the old Paleozoic floor of the Trinity sea must have been very irregular. This accounts, in part, for the variations in thickness of the sections, particularly of the Sycamore member. This phenomenon seems to be true regardless of whether the formation is observed at the surface or is encountered in wells.

Similar to most of the Cretaceous-Pennsylvanian contacts, a conglomerate occurs at the base of the Travis Peak. This conglomerate consists of an accumulation of different sizes of boulders and pebbles of various composition. Ordinarily, pieces of Paleozoic limestones, particularly Ellenburger and Marble Falls, cherts, granites, schists, and quartz are found. The pebbles and boulders composing the conglomerate vary in size, shape, and angularity, according to the locality under consideration.

The variation in size of the pebbles and boulders in the basal conglomerate is significant. The thickness of the conglomerate and the size of the stones in the matrix furnishes direct information regarding the relative position of the old land mass which supplied the sediments as well as the probable elevation of the land above the Travis Peak sea. The basal conglomerate, together with the coarse sands and red sandstones of the Sycamore member, have a thickness of about 50 feet in Burnet County. These sediments tend to thicken southward,

[5] R. T. Hill, "Geography and Geology of the Black and Grand Prairies, Texas," *U. S. Geol. Survey 21st Ann. Rept.*, Pt. 7 (1901), p. 142.

having a thickness of about 600 feet at Austin, 125 feet at Cox's Crossing, 100 feet at Hammett's Crossing, and 72 feet at Dead Man's Hole. The Sycamore beds do not crop out in Comal County, but in well sections are found to have a thickness of about 65 feet.

At the type locality, the conglomerate consists of pebbles and boulders ranging from coarse grit to fragments about 8 inches in diameter. East of Spicewood, the basal conglomerate crops out also, the boulders being as large, or larger, than those in Burnet County. The top of it is also visible a short distance south of Cox's Crossing, in the bed of Pedernales River, and at Hammett's Crossing on the west bank of the river near the bridge. The thickness of the conglomerate is 42 feet near the mouth of the creek draining Dead Man's Hole.

Sandy marl, which is included in the 50 feet of sediments situated below the Cow Creek beds at the type locality, directly overlies this conglomerate. This marl thickens and persists southward, following Pedernales River to Hammett's Crossing where it has a thickness of 62 feet. These clays also crop out along Pedernales River, and at the mouth of the creek draining Dead Man's Hole, they are 30 feet in thickness. Due to structural conditions, there are no good outcrops of these beds in southern Hays or Comal counties.

The Sycamore is undoubtedly the most variable of the members of the Travis Peak and, as has been suggested previously, represents the earliest exposed Cretaceous deposits in central Texas. These sediments are not typical of Travis Peak everywhere and probably do not exist for long distances with the same relationship to other members. It is the Cow Creek and Hensell members, therefore, that are persistent over long distances and should be more dependable as markers of the Travis Peak than the Sycamore. It is obvious that because the conglomerate was deposited in a transgressing sea, its age should vary.

COW CREEK MEMBER

The term Cow Creek beds, proposed by Hill,[6] is applied to the limestones forming the middle part of the Travis Peak formation. They are typically exposed on Cow Creek above the junction of Post-oak Creek, in northwestern Travis County. These beds are distinguishable from those in other parts of the formation because of their lithologic characteristics and the abundance of fossils. Generally, the limestones are hard, massive, and grayish white to cream-colored. The upper part of the member is in some places dolomitic. At the type locality on Cow Creek, the limestones have a total thickness of 30 feet. As a whole, they tend to thicken southward, the fossiliferous

[6] *Op. cit.*, pp. 142–43.

beds, however, maintaining approximately the same thickness as those on Cow Creek. In addition to becoming thicker toward the south, the limestones become arenaceous. Many of the fossils found at the type locality of the Cow Creek beds occur in the southern outcrops of this member.

The gradual thickening of the Cow Creek beds and their equivalents southward, is illustrated by a comparison of the thicknesses at various localities. At Cox's Crossing, the thickness of this member has increased from 30 feet at the type locality to 56 feet. These beds are well exposed along the bluffs of Pedernales River south of Cox's Crossing. About 5 miles west of Cox's Crossing, in Burnet County, the upper Cow Creek beds are exposed in a creek on the north side of the Austin-Marble Falls highway. Fossils are found in profusion at this locality. About 2 miles southeast of Cox's Crossing, the Cow Creek beds are well exposed on Milam's place. This is another good locality for collecting fossils.

The Cow Creek beds crop out along the course of Pedernales River, at and between Cox's Crossing and Hammett's Crossing. These beds form the bluffs along the banks of the river. The strata are well exposed, also, at West Cave, $\frac{1}{2}$ mile west of Hammett's Crossing, and at Hamilton Pool, on Hamilton Creek, about $1\frac{1}{4}$ miles east of the crossing.

The Cow Creek beds also crop out along Pedernales River from Hammett's Crossing into Hays County, thence southward to Dead Man's Hole, where the strata are beautifully exposed. This is an excellent locality for making fossil collections. South of Dead Man's Hole, the outcrops are interrupted by structural conditions, chiefly faults. Perhaps the best outcrop of the middle part of the Travis Peak south of the vicinity of Dead Man's Hole is on Rebecca Creek, in northwestern Comal County, where the Cow Creek beds or their equivalents have a total thickness of about 78 feet.

A large number of the fossils which are found in the Cow Creek beds at the type locality are represented at these localities in Comal County. The general nature of the beds is about the same throughout the horizontal extent of the outcrop of the formation, except for the gradual thickening toward the south, and for their arenaceous character in that direction.

HENSELL MEMBER

The term Hensell sands is applied to the sands, sandy clays, sandstones, arenaceous limestones, and conglomerates which compose the upper part of the Travis Peak formation. They were named by Hill[7]

[7] *Op. cit.*, pp. 143–44.

for Hensell's place, in northwestern Travis County. This member of the Travis Peak formation is typically exposed at this locality. It is not difficult to distinguish the Hensell from other parts of the formation because of its lithologic character and its position directly above the Cow Creek beds. Generally, the sands are cream-colored to reddish and are commonly calcareous. In the upper parts, they grade into sandstones and arenaceous limestones. In many places, beds of conglomerates and clays are found interstratified with them. The uppermost beds of the Travis Peak are considered in the discussion of the Glen Rose-Travis Peak contact.

The Hensell sands, at the type locality, have a thickness of 183 feet, the upper 40 feet composed of conglomerates, sandstones, and sandy limestones. The thickness of this member varies in the horizontal extent of the formation because of the nature of the sediments and the conditions under which they were deposited. They have a tendency to thin southward from the type locality. At Cox's Crossing, the sediments above the Cow Creek beds have thinned from 183 feet at the type locality to 80 feet. They are well exposed south of the Austin-Marble Falls highway, about 5 miles west of Cox's Crossing. There is another good outcrop of this member of the Travis Peak on Milam's place, about 2 miles southeast of Cox's Crossing, where it has about the same thickness. The same sediments crop out along the hills on each side of Pedernales River intermittently between Cox's Crossing and Hammett's Crossing. On top of the bluff, formed by the Cow Creek beds, on the east side of the river at Hammett's Crossing, the sands and sandy clays have a total thickness of 79 feet. These sands are also exposed on the Cypress Mill-Austin highway between the crossing of Hamilton Creek and Shingle Hills, where the section is approximately the same as at Hammett's Crossing. At Dead Man's Hole, Hays County, the thickness of the sandy material corresponding with the Hensell sands is 72 feet, at the top of which the Glen Rose-Travis Peak contact is evident. The base of the Glen Rose is marked by the genus *Toucasia;* otherwise, the change from the Glen Rose to the Travis Peak is almost imperceptible.

In Comal County, there are several good outcrops of the upper sands, which are equivalent to the Hensell sands. Along Rebecca Creek, they have a thickness of approximately 45 feet. In this region, this part of the Travis Peak is marked by the presence of geodes, ranging from 2 to 10 inches in diameter, which are plentiful in many places, covering the weathered surface of the sands. Another good outcrop of geodes occurs in the same stratigraphic position along the New Braunfels-Blanco highway at the junction of the first Spring Branch road west of New Braunfels. On top of the bluff on the north

bank of Guadalupe River, at Speck's Crossing, the sandy materials between the Cow Creek beds and the Glen Rose have a thickness of 40 feet. The thinning of the upper sands from 183 feet in Burnet County to 40 feet in Comal County is noteworthy.

GLEN ROSE-TRAVIS PEAK CONTACT

Similarity in the lithologic character of the Glen Rose and Travis Peak formations in many places causes difficulty in locating the contact between the two. The character of the contact between the Glen Rose and Travis Peak formations is not the same everywhere. In the normal succession of beds from the upper Travis Peak to the lower Glen Rose, trouble arises in distinguishing them because of lithologic similarities; the arenaceous limestones and calcareous sandstones of the upper Travis Peak grading into the arenaceous limestones of the lower Glen Rose. Due to this likeness, drillers have difficulty in separating the two formations. Another factor which makes the separation of the formations even more difficult, is that the Travis Peak crops out within the Balcones fault zone, resulting in places in the displacement of the contact.

As the contact is traced from its outcrop in southeastern Burnet County to western Comal County, the general character of the upper Travis Peak remains the same. An arenaceous limestone is ordinarily present in the uppermost part of the formation. Ordinarily, this bed is about 2 feet in thickness and is the result of a uniform deposition of sediments. Because of this uniformity in deposition, the conclusion is drawn that the basal beds of the Glen Rose are the ones which have changed in character. In Comal County the Glen Rose is approximately 740 feet thick. The thinning of this formation toward the north is gradual, and may be explained as being due to a progressive overlap of the Glen Rose sea, in which the lower beds of the formation were not deposited as the sea progressed north and west. The base of the Glen Rose in Burnet County corresponds approximately with the middle of the section in Comal County. It is the constant changing of the lower beds of the Glen Rose, therefore, which makes the separation of the two formations difficult.

Hill[8] defines the Glen Rose-Travis Peak contact by the statement that the "lowest appearance of the peculiar fossils *Monopleura* and *Requienia* . . . indicates the beginning of the Glen Rose formation." The writer has collected from various outcrops of the Travis Peak formation and has found in many places that this definition is reliable.

The writer has found that on outcrops, the best way in which to

[8] R. T. Hill, "Geography and Geology of the Black and Grand Prairies, Texas," *U. S. Geol. Survey 21st Ann. Rept.*, Pt. 7 (1901), p. 144.

determine the Glen Rose-Travis Peak contact is to locate the Cow Creek beds, then go up in the section through the Hensell sands until hard limestones, which are neither conglomeratic nor exceedingly arenaceous, are encountered. Ordinarily, these beds are the lowermost strata of the Glen Rose.

At the Hickory Creek section of the Travis Peak, the uppermost beds consist of sands, arenaceous limestones, calcareous sandstones, and conglomerates. Directly above the topmost conglomeratic limestone of this formation, occurs hard, massive, cream-colored limestone above which occur alternating beds of limestone and clays. This cream-colored limestone marks the beginning of the Glen Rose beds.

Another contact of the Glen Rose and Travis Peak occurs along the Austin-Marble Falls highway and may be observed on the hill just east of Pedernales River. At this locality, the basal Glen Rose is marked by the presence of *Monopleura* and *Toucasia* and an abundance of *Orbitolina texana* Roemer.

The Glen Rose-Travis Peak contact is also exposed about 5 miles west of Cox's Crossing on the south side of the Austin-Marble Falls highway. At this locality, the upper Travis Peak is very sandy and conglomeratic, whereas, the basal bed of the Glen Rose is hard, massive limestone containing fragments of *Toucasia*. Stratigraphically this layer is only about 5 feet above a conglomerate in the upper Travis Peak. The contact of the Glen Rose and the Travis Peak formations between Hamilton Pool and Shingle Hills has essentially the same characteristics.

In general, it might be said that the Travis Peak is sandy throughout, whereas, the Glen Rose is sandy only in certain phases. The Travis Peak sands are ordinarily coarse, whereas those of the Glen Rose are fine.

PALEONTOLOGY

The paleontologic character of the Travis Peak in this region has been studied less than that of any of the other Cretaceous formations. Ordinarily, the fossils present in the Travis Peak are in zones and are limited rather than distributed generally throughout the formation. Even in these zones, it is only rarely that the actual shells of the fossils are preserved. There is ordinarily some difficulty in identifying the Travis Peak fossils because of their state of weathering, which generally results in the absence of surface ornamentation and other characteristics which are used in taxonomic work. Most of the fossils are in the form of molds and are fragmentary. Many of them are preserved in the form of calcite pseudomorphs, and are easily broken or weathered. The absence of dentition in many of the molds

of pelecypods makes it particularly difficult to identify many of the specimens, even as to genus.

Although it is not possible to consider many of the fossils of the Travis Peak, the writer feels that it is particularly important that a statement be made with reference to *Orbitolina texana* Roemer. This species is ordinarily considered as being only of Glen Rose age. In the upper Hensell sands, however, about 4 miles west of Cox's Crossing, at a point approximately 17 feet below the top of the Travis Peak, this species occurs in profusion. The specimens vary greatly in size, have rolled margins, and are more siliceous than those in the Glen Rose. The silica is doubtless due to the occurrence of these specimens in the sandy material in the Travis Peak, whereas, in the Glen Rose, they are ordinarily found in more calcareous material. At first, the species was thought to be new, but upon comparison with the Glen Rose form of *O. texana*, they were found to be the same. This means, then, that many of the well samples determined as being of Glen Rose age on the basis of this species, may instead be Travis Peak.

GEOLOGIC HISTORY

A knowledge of the geologic history of the Trinity group is essential to the understanding of conditions under which the Travis Peak was deposited. These conditions, the position of the land masses which furnished the sediments for the group as a whole, the approximate depth of the sea when the different sediments were being deposited, the direction of the encroachment of the old Trinity sea, the rapidity with which it advanced, and the relative ages of the various formations of the group, are fairly well known.

In general, sediments of the Trinity group were deposited on a subsiding sea floor, the chief sources of supply being (1) Ouachita Mountains, (2) Arbuckle Mountains, (3) Wichita Mountains, (4) Llano-Burnet region, and (5) other areas of older sedimentary rocks. In general, the nature of the sediments indicates near-shore conditions, resulting in the deposition of conglomerates, sands, sandstones, sandy clays, and much arenaceous limestone.

The present distribution of the formations in the Trinity group by no means represents the western boundary of the old Trinity sea. Erosional remnants of deposits extend farther west and northwest of the outcrop in central Texas, indicating that in Trinity time, Texas was well covered by the sea. On the northeast, east, and south, the Travis Peak is well developed in the subsurface. The first encroachment of the Cretaceous sea on the area of central Texas came from Mexico and the southeast. This incursion was made by a shallow marginal sea which advanced rapidly upon the older rocks. The na-

ture of the sediments indicates shallow, near-shore conditions, and a rapid advancement of the sea. The Paleozoic land mass upon which the sea advanced was topographically higher on the north and west. Because of the overlap of the sea from the south, the "Basement sands," or basal Cretaceous sediments, differ in age in various localities, becoming younger toward the north from southern Texas, until in southern Kansas, they are of Washita age, although they represent initial deposits of the Cretaceous sea in that area. The nature of the sediments of the Travis Peak indicates that this region was high topographically. The edge of the mass must have sloped steeply toward the sea and the gradients of the streams must have been steep, in order to produce a conglomerate with such large boulders as those found in the basal Travis Peak. These boulders, which are large and well rounded, indicate that they must have been transported some distance from their points of origin and carried in streams with relatively swift currents. They are commonly fragments of Ellenburger and Marble Falls limestones, granites, schists, and quartz derived from the adjacent pre-Cambrian, igneous, and Paleozoic rocks. The region must have been much higher in early Travis Peak time than later because the sediments grade from very coarse conglomerates to fine-grained materials. The lowering of the land mass during Trinity time might have been caused by erosion or by structural conditions. As the land mass was eroded, the sea advanced on the land and the materials deposited away from the shore were fine and calcareous, as indicated in the upper part of the Travis Peak.

Incident to being deposited on an irregular sea floor, the thickness of the Travis Peak formation in different localities varies. Minor irregularities in thickness of the different members of the formation are encountered in many places, particularly in the sandy phases which show variations in deposition. Because the invasion of the sea was from the south and east, the formation is thicker in those directions.

CONCLUSIONS

1. The Travis Peak formation is divided into three parts: the lower, Sycamore member, consisting of conglomerates, sands, and clays; the middle, the Cow Creek member, consisting essentially of limestones; and the upper, Hensell member, consisting of sands and clays.

2. The basal member, the Sycamore, is composed of materials characteristic of the first deposits of a transgressing sea. The conglomerates present in the lower part of the Sycamore are found in different stratigraphic positions in various sections. As the beds are

traced northward from Mexico, the conglomerates become younger in age. This raises the question as to whether they should be considered as a part of the Travis Peak proper which may be recognized in large areas. As the Cow Creek and Hensell members are more uniform in extent, they are more typical of the Travis Peak as a whole.

3. The Travis Peak in central Texas rests on Pennsylvanian rocks of varying age due to the overlap, and forms an angular unconformity.

4. The fauna of the Travis Peak is, for the most part, restricted to the Cow Creek beds, and consists chiefly of pelecypods, gastropods, a few ammonites, corals, and foraminifera.

5. The fauna of the Travis Peak closely resembles the Glen Rose; however, the writer believes the two formations are distinctive units although lithologically they are similar. The Cow Creek and Hensell members are nearly uniform in their sections and distribution in central Texas, but the lower part of the Glen Rose is not present everywhere, causing different Glen Rose beds to be in contact with the Travis Peak.

6. The top of the Travis Peak in central Texas is placed at the top of sandy beds of the Hensell member. The Glen Rose beds are ordinarily more calcareous.

7. The type locality section of the Travis Peak, because of its location on the side of the Llano uplift, necessarily is much thinner than the downdip facies. For purposes of correlation, it is unfortunate that more of the subsurface section does not crop out at the type locality.

8. The Travis Peak is much thicker in many subsurface sections than at its outcrops in central Texas.

9. The Travis Peak or its subsurface equivalent has been traced by the writer through Texas to Louisiana and Arkansas.

In order that outcrops of the Travis Peak formation may be found without difficulty, the following list of localities where excellent exposures can be observed is given.

1. Along Colorado River between the valleys of Sycamore and Cypress creeks, in Burnet, Blanco, and Travis counties
2. Southeast of the Travis Peak Post Office on Cow Creek, Travis County
3. From the top of the divide between Hickory and Cow creeks and continuing to Colorado River level at the mouth of Hickory Creek, Burnet County
4. Near Hensell's house, at the Travis Peak Post Office, Travis County, where the Hensell sands are exposed at their type locality
5. On Cow Creek, above the entrance of Postoak Creek, Travis County, where the Cow Creek beds are well exposed at their type locality
6. Along the slopes of Colorado River valley from the river level at the crossing of the Burnet-Travis county line to a point a mile or two up Sycamore Creek where the Sycamore sands crop out at their type locality
7. In Comb's Hollow below the junction of the main Austin-Smithwick highway and the Liberty Hill road, Travis County
8. In Turnback Creek between Cow Creek and Comb's Hollow where the Cow Creek beds and Hensell sands crop out

9. Along Spanish Oak Creek, Burnet and Travis counties, where the middle and upper parts of the Travis Peak crop out
10. About 3 miles east of the town of Spicewood, in Travis County, where the basal conglomerate of the Travis Peak crops out
11. The bluff on the west side of Pedernales River, about ¾ mile up the river from Cox's Crossing, Travis County, where there is an excellent exposure of the Cow Creek beds. The basal conglomerate may be observed in the bed of the river at this locality
12. About 5 miles west of Cox's Crossing on the south side of the Austin-Marble Falls highway, Burnet County, where there is a good outcrop of the upper sands of the Travis Peak overlain by the Glen Rose-Travis Peak contact
13. B. B. Milam's place, on the southeast side of Pedernales River, about 2 miles from Cox's Crossing, Travis County, where the middle and upper parts of the Travis Peak crop out
14. On the bluffs of Pedernales River at Hammett's Crossing, Travis County, where the Cow Creek beds are well exposed
15. On the hills south of the highway on the east side of Pedernales River, Hammett's Crossing, Travis County, where the Cow Creek beds are exposed
16. At West Cave, about ½ mile west of Pedernales River, in the first creek north of Hammett's Crossing, Travis County, where the Cow Creek beds are exposed
17. Hamilton Pool, about 1¼ miles east of Pedernales River, and about ¼ mile north of the highway from Hammett's Crossing to Austin, where there is a good exposure of the Cow Creek beds
18. Dead Man's Hole, Hays County, about 2½ miles airline S. 40° W. from Hamilton Pool where the Cow Creek beds and Hensell sands are beautifully exposed
19. At the town of Spring Branch, Comal County, where the sands of the upper Travis Peak crop out
20. On Rebecca Creek, Comal County, about 4½ miles northeast from Spring Branch where the Cow Creek beds are well exposed, forming high bluffs on each side of the creek
21. Along the north bank of Guadalupe River, about 1 mile upstream from Speck's Crossing, Comal County, where the middle and upper parts of the Travis Peak crop out
22. On the hills southwest of Speck's Crossing of Guadalupe River, Comal County, where the upper part of the Travis Peak crops out
23. Along the New Braunfels-Blanco Highway at the junction of the first Spring Branch road west of New Braunfels, where there is a good assortment of geodes.

BIBLIOGRAPHY

The references which follow do not by any means comprise a complete bibliography on the Travis Peak formation. Most of the references to paleontology and many on stratigraphy have been omitted.

BOYLE, C. B., "A Catalogue and Bibliography of North American Mesozoic Invertebrates," *U. S. Geol. Survey Bull. 102* (1893).

BRILL, V. A., "The Travis Peak Formation," unpublished M. A. thesis, The University of Texas, 1928.

BULLARD, F. M., "Lower Cretaceous of Western Oklahoma," *Oklahoma Geol. Survey Bull. 47* (1928).

BURCKHARDT, CARLOS, "La Faune Jurassique de Mazapil," *Inst. Geol. Mexico Bol. 23* (1906).

———, "Faunes Jurassiques et Cretaceques de San Pedro del Gallo," *ibid., Bol. 29* (1912).

———, "Faunas Jurassicas de Syman (Zacatecas)," *ibid., Bol. 33* (1919).

———, "Faunas del Aptiano de Nazas (Durango)," *ibid. Bol. 45* (1925).

———, "Etude Synthetic sur le Mesozoique Mexicain," *Me. Soc. Paleon. Suisse*, Vol. 49–50 (1930).

CLARK, C. C., "Sugar Creek Field, Claiborne Parish, Louisiana," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 22, No. 11 (November, 1938), pp. 1504–18.

CONRAD, T. A., *Report of the United States and Mexican Boundary Survey*, Vol. I (1857).

COQUAND, M. H., *Monographie Paleontologique de l'Etage Aptien de l'Espagne.* Paris (1866).
CORRELATION PAPERS, "Cretaceous," *U. S. Geol. Survey Bull. 82* (1891).
CRAGIN, F. W., "Invertebrate Paleontology of the Texas Cretaceous," *Texas Geol. Survey 4th Ann. Rept.* (1893).
———, "Description of Invertebrate Fossils from the Comanche Series in Texas, Kansas and Indian Territory," *Colorado College Studies Ann. Pub. 5* (1894).
———, "Notes on Some Fossils of the Comanche Series," *Science,* New. Ser., Vol. 6 (1897).
———, "Paleontology of Malone Jurassic Formation of Texas," *U. S. Geol. Survey Bull. 266* (1905).
DE LORIOL, P., "Monographie des couches de l'Etage Valanginen des Corrieres d'Arzier (Vaund)," *Materiaux pour Paleontologie Suisse* (1863).
DEUSSEN, ALEXANDER, "Geology of the Coastal Plain West of the Brazos River," *U. S. Geol. Survey Prof. Paper 126* (1924).
DOUVILLE, H., "Sur les couches a Rudistes du Texas," *Bull. Soc. Geol. France,* No. 3 (1898), p. 387.
———, "Sur Quelques Rudistes Americains, Texas," *ibid.,* XXVIII (1900), p. 218.
———, "Sur la distribution geographique des Rudistes, des Orbitolines et des Orbitoides," *ibid.,* No. 3, XXVIII (1900), p. 222.
DUMBLE, E. T., "The Geology of East Texas," *Univ. Texas Bull.* (1918), p. 1869.
GORDON, C. H., "Geology and Underground Waters of Northeastern Texas," *U. S. Geol. Survey Water Supply Paper 276* (1911). 78 pp., 2 pls.
GOULD, C. N., "Lower Cretaceous of Kansas," *Amer. Geol.,* Vol. 25 (1900), pp. 10–40.
GRECO, B., "Fauna Cretacea dell' Equitto Raccolta dal Figarie Bey; Lamellibranchi del Turoniano e del Cenomaniano," *Paleontographia Italica,* Vol. 24 (1918).
HENDERSON, G. G., "The Geology of Tom Green County," *Univ. Texas Bull. 2807* (1928).
HILL, R. T., "Present Knowledge of the Geology of Texas," *U. S. Geol. Survey Bull. 45* (1887).
———, "Texas Section of the American Cretaceous," *Amer. Jour. Sci.,* 3rd Ser., Vol. 34 (1887), pp. 287–309.
———, "Trinity Formation of Arkansas, Indian Territory, and Texas," *Science,* Vol. 17 (1888), p. 21.
———, "Neozoic Geology of Southwestern Arkansas," *Arkansas Geol. Survey Ann. Rept. for 1888,* Vol. 2 (1889).
———, "Cretaceous Rocks of Texas and Their Economic Uses," *Geol. Survey Texas 1st Ann. Rept.* (1890).
———, "Events in North American Cretaceous History Illustrated in the Arkansas Texas Region," *Amer. Jour. Sci.,* 3rd Ser., Vol. 37 (1889), pp. 282–90.
———, *Paleontology of the Cretaceous Formations of Texas.* Austin (1889).
———, "The Comanche Series of the Arkansas-Texas Region," *Bull. Geol. Soc. America,* Vol. 2 (1890), pp. 503–28.
———, "Notes on the Texas-New Mexico Region," *ibid.,* Vol. 3 (1891), pp. 85–100.
———, "Invertebrate Paleontology of the Trinity Division," *Biol. Soc. Washington,* Vol. 8 (1893).
———, "The Paleontology of the Cretaceous Formation of Texas," *Proc. Biol. Soc. Washington,* VIII (1893).
———, "Geology of Parts of Texas, Indian Territory, and Arkansas Adjacent to Red River," *Bull. Geol. Soc. America,* Vol. 5 (1894).
———, "Geology of the Edwards Plateau and Rio Grande Plain Adjacent to Austin and San Antonio, Texas, with References to the Occurrence of Underground Waters," *U. S. Geol. Survey 18th Ann. Rept.,* Pt. 2 (1897).
———, "The Geography and Geology of the Black and Grand Prairies of Texas," *U. S. Geol. Survey 21st Ann. Rept.,* Pt. 7 (1901).
———, and VAUGHAN, T. W., "Austin, Texas," *U. S. Geol. Survey Geol. Atlas Folio 76* (1902).
JONES, C. T., "Cretaceous and Eocene Stratigraphy of Barilla and Eastern Davis Mountains," *Bull. Amer. Assoc. Petrol. Geol.,* Vol. 22, No. 10 (October, 1938), pp. 1423–39.
KELLUM, L. B., "Paleogeography of Parts of the Border Province of Mexico Adjacent to West Texas," *ibid.,* Vol. 20, No. 4 (April, 1936), pp. 417–32.
LASKY, S. G., "Newly Discovered Section of Trinity Age in Southwestern New Mexico," *ibid.,* Vol. 22, No. 5 (May, 1938), pp. 524–40.

LIDDLE, R. A., "The Geology and Mineral Resources of Medina County," *Univ. Texas Bull. 1860* (1918).
MARCOU, JULES, "Notes on the Cretaceous and Carboniferous Rocks of Texas," *Proc. Boston Soc. Nat. Hist.*, Vol. 8 (1927), pp. 86–97.
MISER, H. D., "Lower Cretaceous Rocks of Southeastern Oklahoma and Southeastern Arkansas," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 11, No. 5 (May, 1927), pp. 443–54.
PAIGE, SIDNEY, "Llano-Burnet, Texas," *U. S. Geol. Survey Geol. Atlas Folio 183* (1912).
PELLAT, E., and COSSMANN, M., "Le Barremien Superieur a Facies Urgonien," *Soc. Geol. France Mem. 27* (1907).
PROSSER, C. S., "Comanche Series of Kansas," *Univ. Geol. Survey Kansas*, Vol. 2 (1897), pp. 51–194.
ROEMER, F., "A Sketch of the Geology of Texas," *Amer. Jour. Sci.*, 2d Ser., Vol. 6 (1846), pp. 358–65.
———, "Contributions to the Geology of Texas, *ibid.* (1848), pp. 21–28.
———, *Die Kreidebildungen von Texas und ihre organischen Einschlusse.* Bonn (1852).
———, *Haefigkeit hippuriten-artiger Chamiden ausgezeichnete fauna der Oberturonen Kreide von Texas.* Berlin (1888).
SCOTT, GAYLE, "On a New Correlation of the Texas Cretaceous," *Amer. Jour. Sci.*, Vol. 12 (1926), pp. 157–61.
———, *Etudes Stratigraphiques et Paleontologiques sur les Terrains Cretaces du Texas.* Grenoble (1926).
SELLARDS, E. H., "The Geology and Mineral Resources of Bexar County," *Univ. Tex. Bull. 1932* (1919).
———, ADKINS, W. S., and PLUMMER, F. B., "The Geology of Texas, Vol. 1, Stratigraphy," *Univ. Texas Bull. 3232* (1932).
SELLARDS, E. H., and BAKER, C. L., "The Geology of Texas, Vol. 2, Structural and Economic," *Univ. Texas Bull. 3401* (1934).
SHUMARD, B. F., "Observations upon the Cretaceous Strata of Texas," *Proc. Boston Soc. Nat. Hist.*, Vol. 8 (1862), p. 89.
SIMONDS, F. W., "Bibliography of Texas for Decade 1890–1900," *Trans. Texas Acad. Sci.*, III (1900).
STANTON, T. W., "Lower Cretaceous Formations and Faunas," *Jour. Geol.*, Vol. 5 (1897), pp. 579–624.
———, "The Cretaceous of Texas," *Amer. Jour. Sci.*, Vol. 13 (1927), pp. 517–22.
STEPHENSON, L. W., "Cretaceous Deposits of the Eastern Gulf Regions and Species of Exogyra from the Eastern Gulf Regions and the Carolinas," *U. S. Geol. Survey Prof. Paper 81* (1914).
———, "A Contribution to the Geology of Northeastern Texas and Southern Oklahoma," *ibid.*, *120* (1918).
———, "The Cretaceous Formations of North Carolina," *North Carolina Geol. and Econ. Survey* (1923).
TAFF, J. A., "Report on the Cretaceous Area North of the Colorado River," *Texas Geol. Survey 4th Ann. Rept.* (1893), pp. 239–354.
TWENHOFEL, W. H., "The Comanchean of Central Kansas," *Trans. Kansas Acad. Sci.*, Vol. 28 (1918), pp. 218–23.
———, "The Comanchean and Dakota Strata of Kansas," *Amer. Jour. Sci.*, 4th Ser., Vol. 49 (1920), pp. 281–97.
UDDEN, J. A., BAKER, C. L., and BÖSE, E., "Review of the Geology of Texas," *Univ. Texas Bull. 44*, 4th Ed. (1919).
WELLER, STUART, "A Report on the Cretaceous Paleontology of New Jersey," *Geol. Survey New Jersey* (1907).
WINTON, W. M., "The Geology of Denton County," *ibid.*, *2544* (1925).
WINTON, W. M., and ADKINS, W. S., "Geology of Tarrant County," *Univ. Texas Bull. 1931* (1919).
WINTON, W. M., and SCOTT, GAYLE, "The Geology of Johnson County," *ibid.*, *2229* (1922).
WHITE, C. A., "On the Cretaceous Formations of Texas and Their Relations to Those of Other Portions of North America," *Proc. Philadelphia Acad. Nat. Sci.* (1887), pp. 39–47.
———, "The Lower Cretaceous of the Southwest and Its Relation to the Underlying and Overlying Formations," *Amer. Jour. Sci.*, 3d Ser., Vol. 38 (1889), pp. 440–45.
WHITNEY, F. L., "Bibliography and Index of North American Mesozoic Invertebrata," *Bull. Amer. Paleontology*, Vol. 12, No. 48 (1928).

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 23, NO. 5 (MAY, 1939), PP. 643-662, 14 FIGS.

SUBSURFACE STUDY OF GREENWICH POOL, SEDGWICK COUNTY, KANSAS[1]

ARNOLD S. BUNTE[2]
Tulsa, Oklahoma

ABSTRACT

The Greenwich oil pool, Sedgwick County, Kansas, comprises parts of Sections 10, 11, 14, 15, and 22 of T. 26 S., R. 2 E. It was discovered by the Shell Petroleum Corporation when Lygrisse A-1 was drilled on a core-drill structure, resulting in a producer in the Viola limestone. The history, development, and geology are briefly discussed. The upper cherty part of the Mississippian limestone, the Viola limestone, and a sandy body near the base of the Simpson formation are the only producing zones of the field. All accumulated production figures are compiled to January 1, 1938.

The Mississippian producing zone, found at a depth of about 2,900 feet, is nearly depleted of oil. This zone has produced a total of 2,095,196 barrels of oil. The per-acre yield has been 6,780 barrels and the average yield per well has been about 52,380 barrels.

The Viola limestone, at the present time, is the main producing zone of the field. It occurs at an approximate depth of 3,200 feet, and has produced a total of about 6,504,319 barrels of oil. The average yield per well has been 144,540 barrels and the per-acre yield has been about 15,125 barrels.

The Simpson reservoir is found at a depth of approximately 3,300 feet. Eight wells on the east flank of the structure have been completed in the formation. The total production has been 316,646 barrels of oil, and the average yield per well has been 39,580 barrels.

HISTORY AND DEVELOPMENT

GENERAL

The Greenwich pool, comprising parts of Sections 10, 11, 14, 15, and 22 of T. 26 S., R. 2 E., Sedgwick County, Kansas, is an important oil field located on an anticlinal ridge, parallel with the Nemaha buried mountains. This structural feature is about 14 miles west of the Nemahas. On it are the Greenwich, Eastborough, Robbins, and other oil pools (Figs. 1 and 2).

The Greenwich structure was located by the Shell Petroleum Corporation in 1925 by core-drill exploration. The core-drill structure, contoured on the base of a shallow Permian limestone, consists of an anticlinal dome of low relief. As it was believed to be the reflection of an anticlinal structure of greater magnitude in pre-Pennsylvanian strata, the Shell drilled P. F. Lygrisse No. A-1, near the crest of the core-drill structure. It was completed in June, 1929, with an initial daily production of 1,985 barrels from the Viola limestone, from which it produced a total of 537,023 barrels of oil during its life of 82 months. It was deepened to the Simpson zone in April, 1936, and completed

[1] Manuscript received, November 29, 1938.

[2] Geological engineer. The writer is indebted to the Shell Petroleum Corporation for records and permission to publish.

at a total depth of 3,304 feet with an initial potential of 114 barrels of oil and no water in 24 hours.

During the period of development a few wells found showings of oil in the Kansas City limestone, but none appears to be of commercial importance. Production in the Mississippian limestone, locally known as the "Chat," was discovered in the Shell Petroleum Corporation's Community No. 1. This well was completed in July, 1929, with an initial daily production of 1,201 barrels and produced a total of 90,868 barrels of oil in 13 months. The Simpson formation was found to be

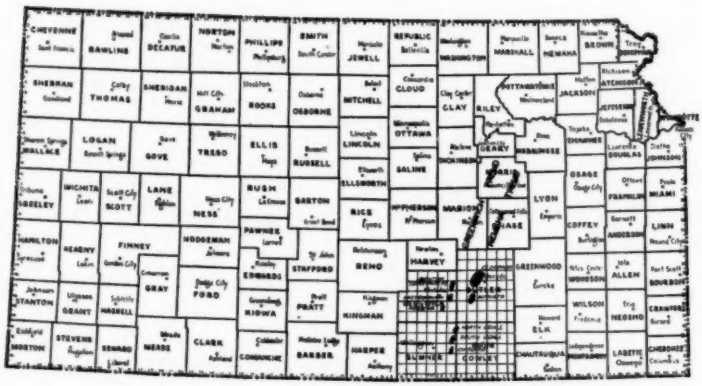


FIG. 1.—Map of Kansas showing location of Greenwich and Nemaha trends.

productive in the Shell's Borg No. 2, which was completed in December, 1929, with an initial production of 264 barrels daily. It produced a total of about 40,000 barrels of oil during its life of 31 months. Borg No. 2, which is located very low on the east flank of the structure, was a failure in both the Chat and Viola zones.

In the fall of 1932, the treating of limestone reservoirs with muriatic acid was introduced. In the spring of 1933, the Shell's Lygrisse A-5 was treated with acid as an experiment. The results were gratifying, and this became a regular procedure after the completions in the Viola limestone. Equal success was found in rejuvenating oil wells nearing their economic limit.

The land and lease boundaries are regular, and as a result, the general spacing plan has been one well to 10 acres. A deviation from this plan was made on four wells where the spacing is one well to approximately 15 acres. The conventional plan of spacing was not applied on the southwestern part of the pool in the Greenwich townsite where

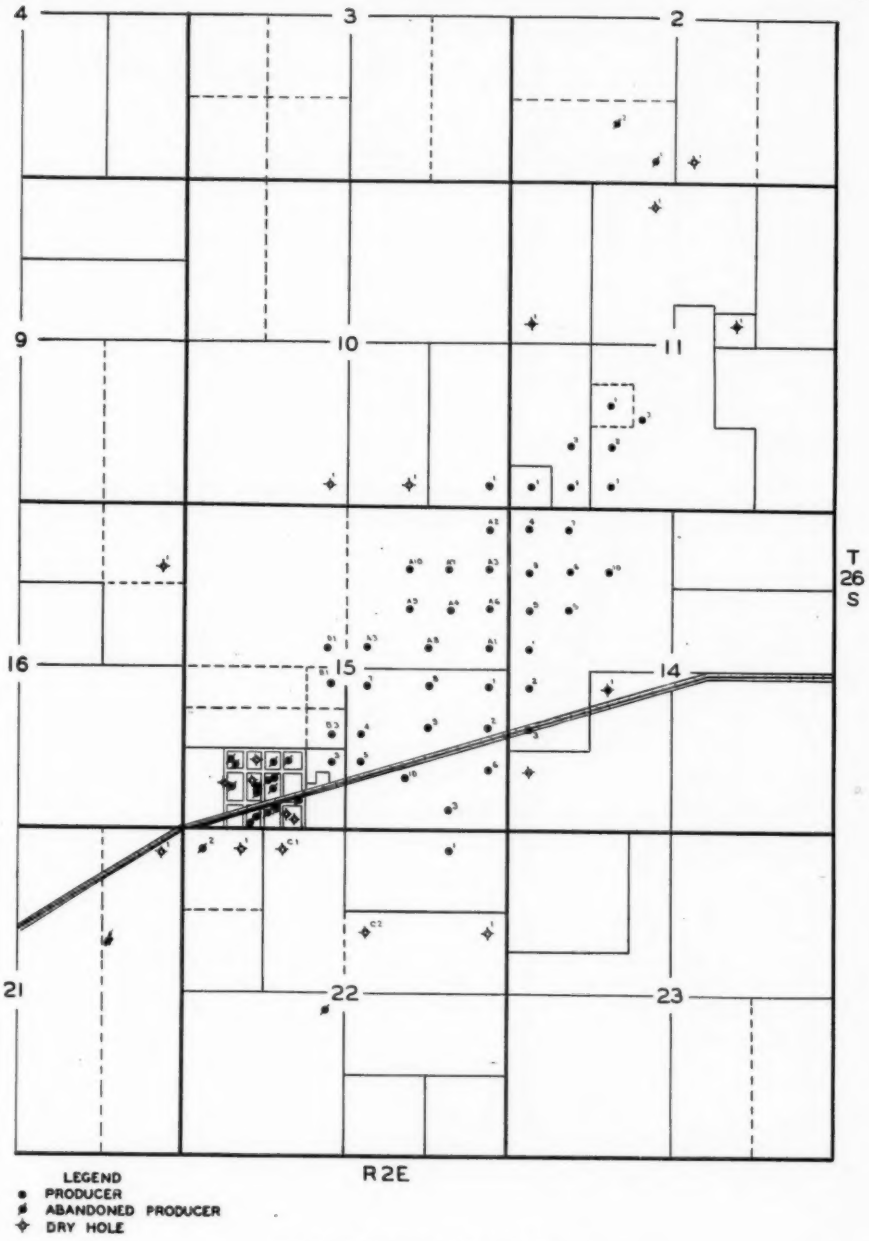


FIG. 2.—Index map of Greenwich pool.

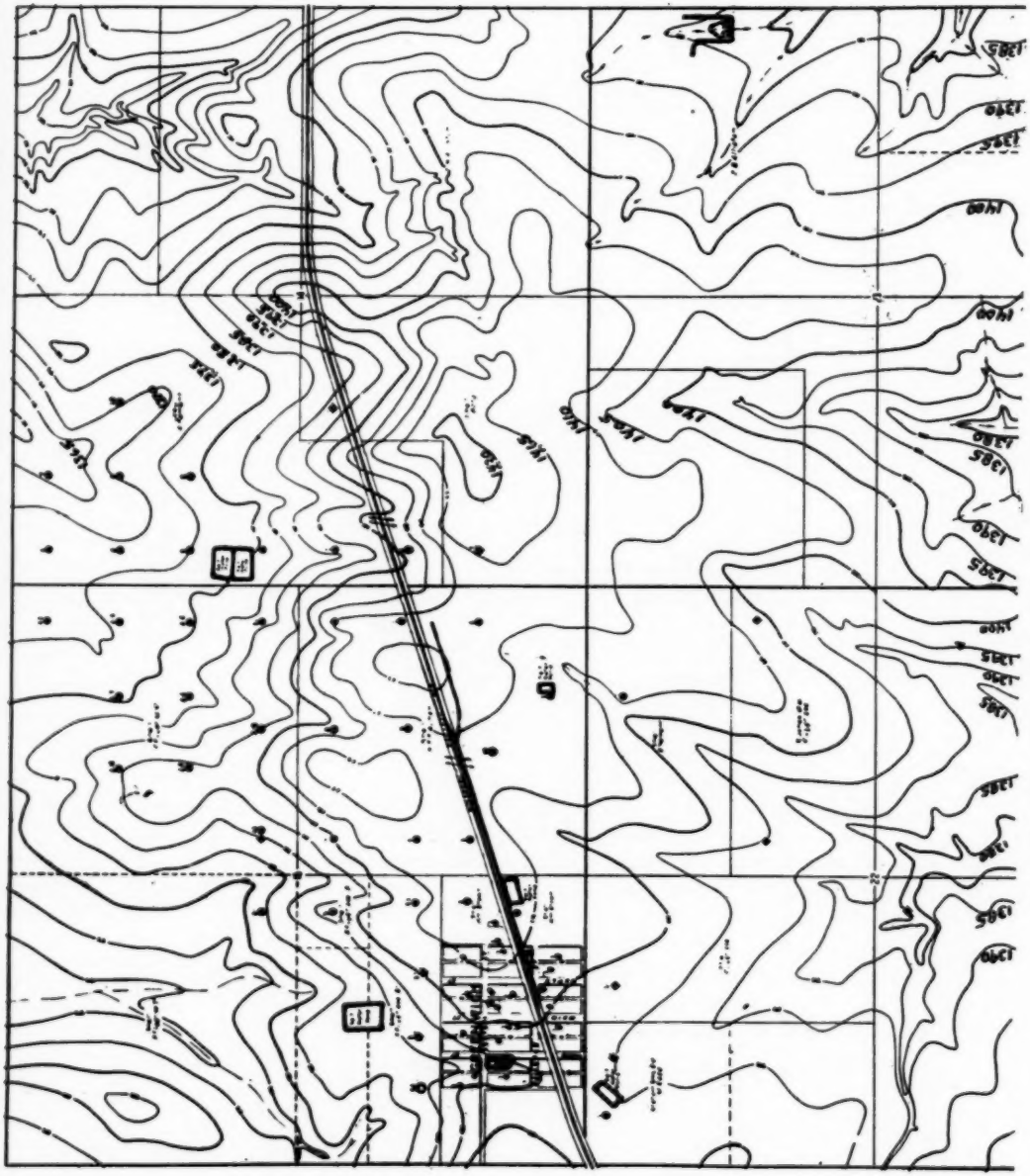


FIG. 3.—Topographic map of Greenwich area, contoured on 5-foot intervals.

wells were drilled on town lots with resultant close and irregular spacing.

The field had produced a total of 8,916,161 barrels of gross oil, 23.5 per cent of which was produced from the Mississippian limestone, 73 per cent from the Viola limestone, and 3.5 per cent from the Simpson formation.

At present, the wells are being produced by individual pumping units.

PRORATION

Laws dealing with conservation of oil and gas in Kansas were enacted by the Legislature as early as 1891, but it was not until 1929 that production was restricted under methods now commonly called "proration." Restriction of production was by voluntary agreement until May 28, 1931, when legal basis for proration was provided for by the Legislature. Since March, 1933, when additional legislation was enacted, proration has been strictly enforced.

Proration was inaugurated in the Greenwich pool, June 1, 1929, when the Shell Petroleum Corporation and the Gulf Oil Corporation, by mutual agreement, restricted the individual production of seven or eight of their larger wells to 100 barrels a day. Each new well in the Viola limestone was likewise restricted to 100 barrels a day. This agreement continued to February, 1931, when the wells were opened to capacity.

Between February, 1931, and March, 1933, proration in the Greenwich pool was not strictly enforced. Potentials were taken at irregular intervals and allowables determined, but the field was often over or under produced. Effective in March, 1933, proration has been strictly enforced; potentials were taken at regular intervals and allowables maintained.

Geology

Regionally, the topography of the area is undulating. About 60 feet of relief is observable in the vicinity of the oil pool, as shown by Figure 3.

No exposures of mappable outcrops are present in the area. As a result, the surface structure could be determined only by core-drilling to a shallow marker.

STRATIGRAPHY

The formations of the Permian and Pennsylvanian systems, having no direct economic bearing in this discussion, are not discussed but are shown in Figure 4, in groups as outlined by the Kansas State Geological Survey.

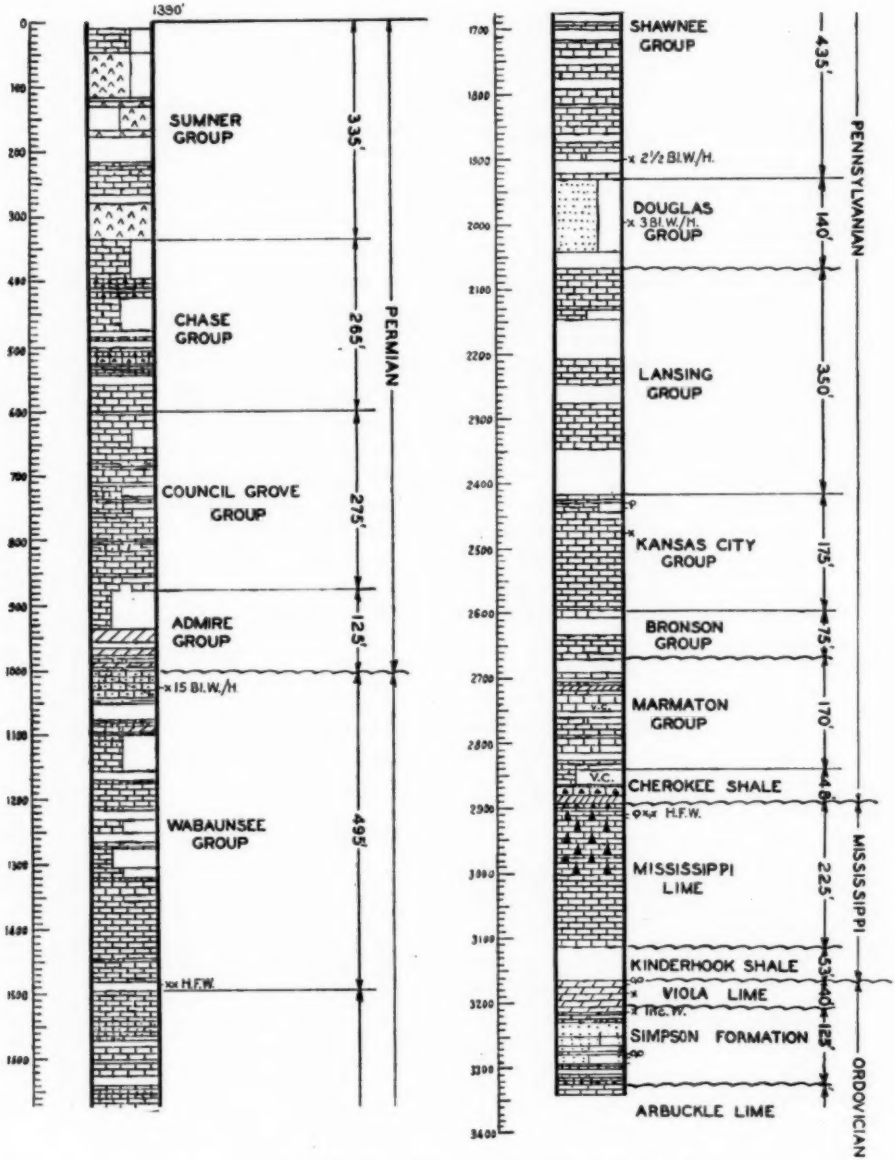


FIG. 4.—Generalized log of Greenwich pool, T. 26 S., R. 2 E.

MISSISSIPPIAN

In late Mississippian time the area was uplifted and the sediments were folded. After the uplift, a cycle of erosion followed. As a result, the Mississippian and older formations unconformably underlie the Pennsylvanian formations.

Mississippian limestone.—The Mississippian limestone, white to gray limestone grading into dolomitic limestone near its base, is found unconformably underlying the Pennsylvanian sediments. The uppermost 150 feet of the formation is characterized by the presence of large amounts of chalky and vitreous chert, associated with limestone. Porous zones found within this cherty part form excellent reservoirs for oil and water. The thickness of the formation in this area varies from 208 to 266 feet (Fig. 5).

Kinderhook shale.—The Kinderhook shale unconformably underlies the Mississippian limestone. It is gray to black pyritic fissile shale containing *Sporangites huronensis*. Its thickness varies from 35 to 94 feet. Figure 6 illustrates the variation in thickness of the formation.

SILURIAN-DEVONIAN

No formations of Silurian-Devonian age have ever been found in this area.

ORDOVICIAN

The Ordovician underlies the Kinderhook shale unconformably. It is brown to white dolomitic limestone. The uppermost one foot of the formation is characterized by the presence of a large amount of pyrite, associated with the dolomite. One well in the area (the Shell's Fischer No. 9) found about 6 inches of conglomerate on top of the dolomite. It was composed of sand with chert pebbles, shale, and phosphate nodules. This appears to be direct evidence of the unconformity between the Kinderhook shale and the Viola limestone. The uppermost part of this formation is very porous, and is an excellent reservoir for oil. The average thickness of the formation in the area is about 40 feet.

Simpson formation.—The Simpson formation unconformably underlies the Viola limestone. It consists of sand with minor amounts of green shale. Water is present in the upper part of the formation. However, near its base, and underlying a thin stratum of green shale, a petroliferous zone is present. The formation has an average thickness of about 125 feet.

Arbuckle limestone.—The Arbuckle limestone unconformably underlies the Simpson formation. This formation consists of white to gray, cherty dolomite.

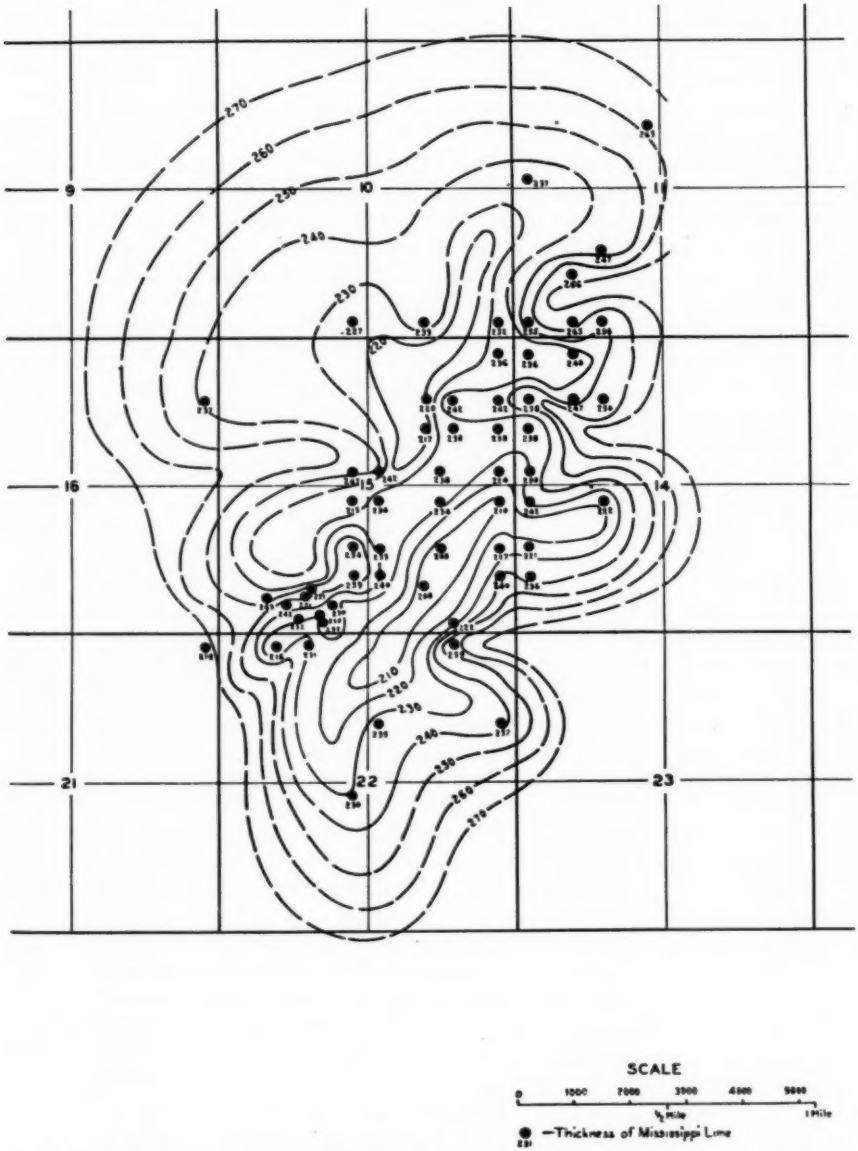


FIG. 5.—Isopach map of Mississippian limestone in Greenwich pool, contoured on 10-foot intervals.

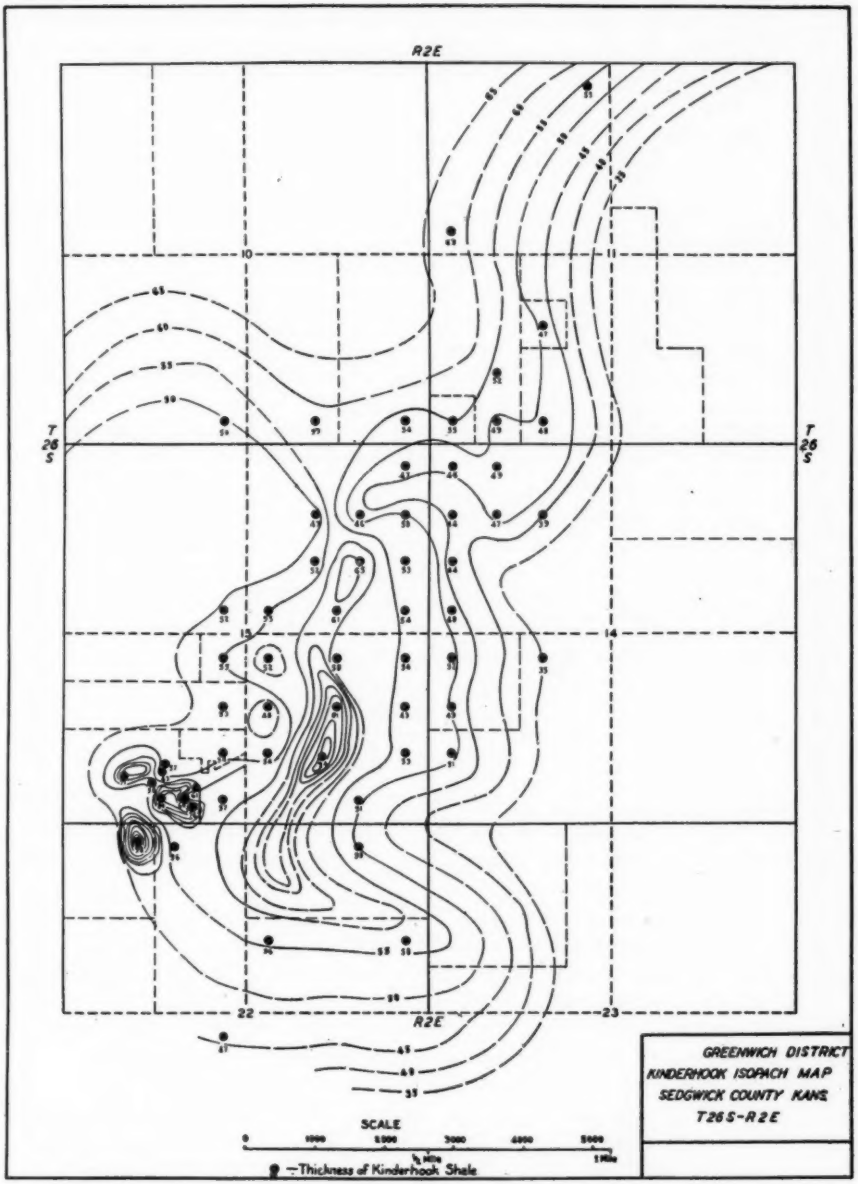


FIG. 6.—Isopach map of Kinderhook shale in Greenwich pool, contoured on 5-foot intervals.

A few light showings of oil have been found in the upper part of this formation but it has not produced commercially. The Arbuckle has been penetrated by the Gulf Oil Corporation's Hamant A-2, drilled for the disposal of salt water, and it was found to have a thickness of about 700 feet.

STRUCTURE

The Greenwich structure is a closed anticline, formed by two periods of folding. The major uplift probably occurred in late Mississippian time. This was followed by a period of erosion. The second uplift is probably post-Permian in age. The structure and relationship of the Ordovician, Mississippian, Pennsylvanian, and Permian are illustrated in Figures 4, 7, 8, 9, and 10.

An inspection of the isopach map of the Kinderhook shale (Fig. 6) suggests that at the end of Kinderhook time, no definite uplift had occurred. The shale has its greatest thickness near the crest of the present structure, and the formation thins in all directions. This indicates that the area was low during Kinderhook deposition. The Mississippian limestone, on the contrary, increases in thickness in all directions (Fig. 5), and, as indicated by the contours drawn on top of the formation (Fig. 7), its surface has been subjected to a severe cycle of erosion. This is sufficient evidence to indicate that the first major uplift was in late Mississippian time. The small amount of relief present in Permian formations, similar but not conformable to the underlying strata, indicates that a second uplift took place in post-Permian time. No faults are present in the area.

PRODUCTION

OIL ZONES

Kansas City limestone.—Showings of oil were found in the Kansas City limestone in several wells. However, they were so small that they were insignificant.

Mississippian limestone.—The porous, cherty zones found within the upper part of the Mississippian limestone have been good oil producers. They are, at present, almost entirely depleted. Due to the lithologic nature of this formation, satisfactory cores can not be obtained for examination. However, it appears that the porosity and permeability of the formation vary greatly between wells and, as a result, the initial potential and ultimate recoveries are greatly controlled by these factors. Most of the wells producing from this formation have been either plugged and abandoned or deepened to the underlying reservoirs. While drilling, a few wells found good showings of

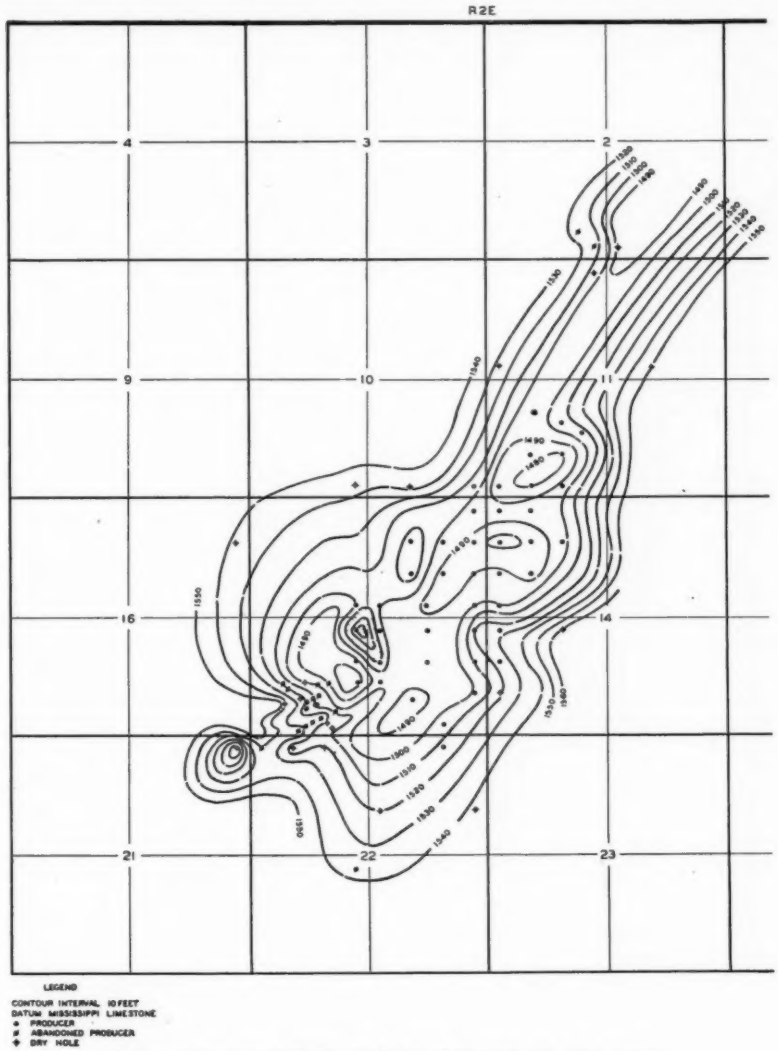


FIG. 7.—Structure of the Greenwich pool, T. 26 S., R. 2 E., on top of Mississippian limestone.

oil, but after testing with a formation tester drilling was resumed and the wells completed in the Viola limestone, leaving the Mississippian oil as a reserve to plug back to and produce at a later date.

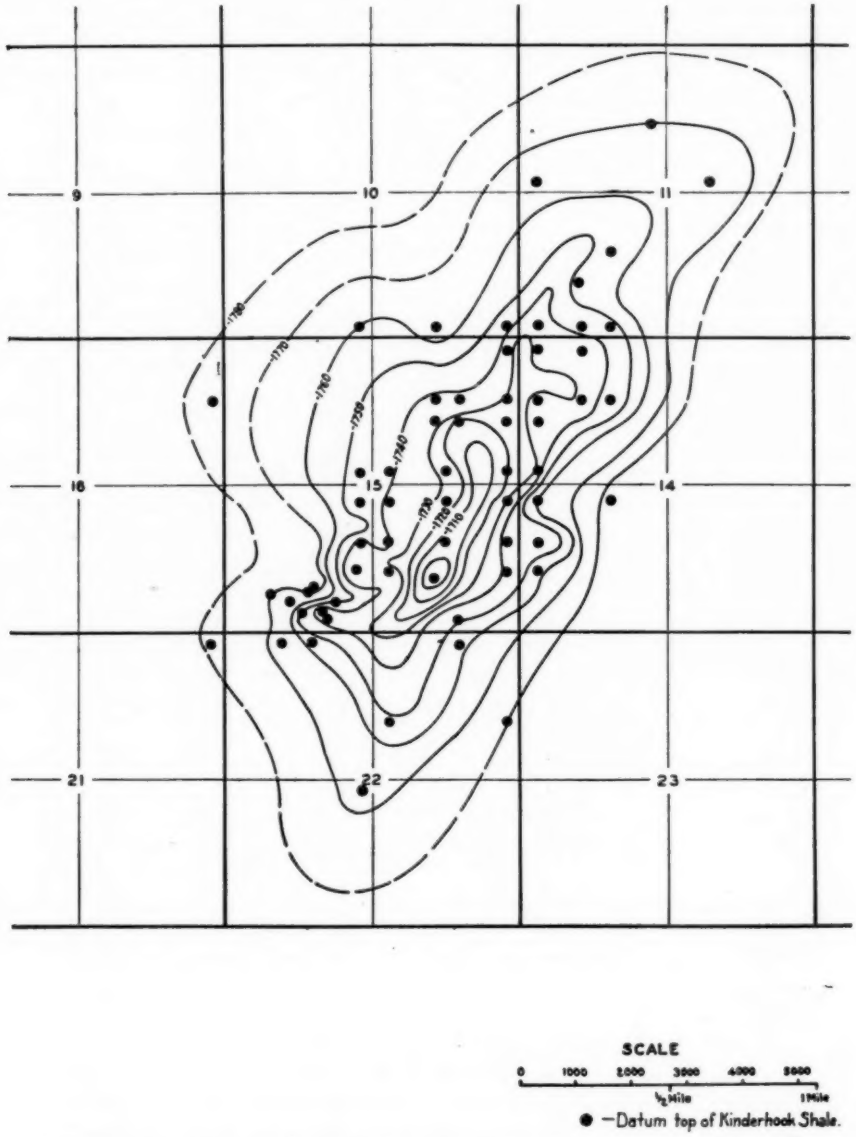


FIG. 8.—Structure map of Kinderhook shale in Greenwich pool, contoured on 10-foot intervals

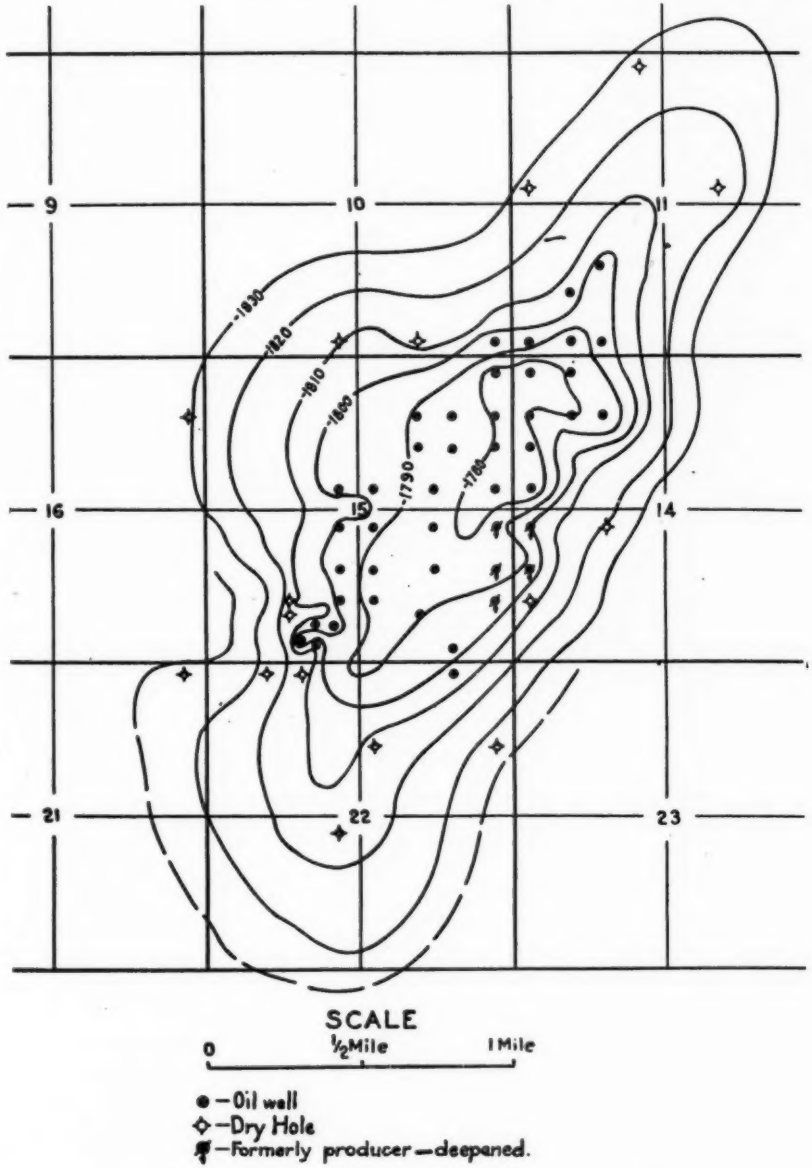


FIG. 9.—Structure map of Viola limestone in Greenwich pool, contoured on 10-foot intervals.

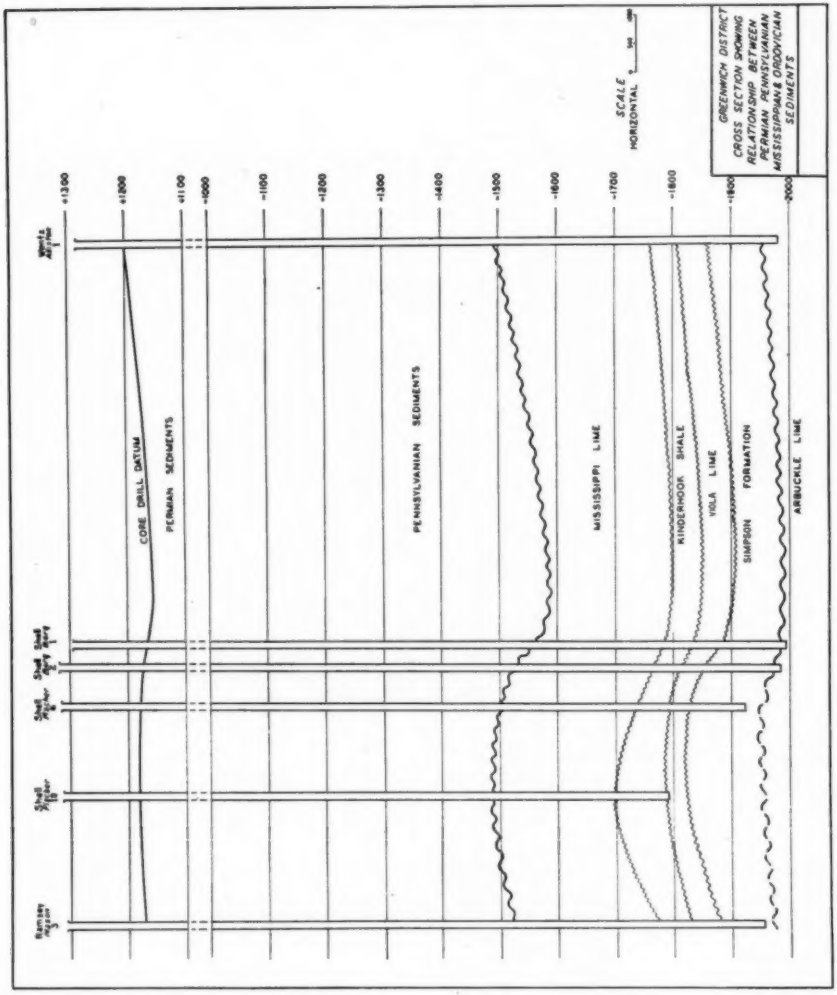


FIG. 10.—Cross section showing relationship of Permian, Pennsylvanian, Mississippian, and Ordovician formations. Scale shown in feet.

The zone never contained much gas and, as a result, all of the oil has been lifted mechanically. The oil has the highest gravity of any oil found on this structure, its average being 43.6° A. P. I. The zone has produced a total of 2,095,196 barrels of oil. This represents a recovery per acre of 6,780 barrels and an average recovery per well of 52,380 barrels (Fig. 11).

Viola limestone.—The Viola limestone reservoir is the most prolific zone of the field. The producing stratum is found at the top of the formation and is generally less than 10 feet in thickness. It consists of a dolomitic limestone, 95 per cent soluble in hydrochloric acid; its average porosity is about 17 per cent. The porosity and permeability of this formation vary considerably; consequently, the initial potentials and ultimate recoveries are greatly controlled by these factors.

A few of the wells flowed initially for a short time, but since very little gas is present, nearly all of the oil has been lifted mechanically. A very pronounced water drive is present in the formation, and water is found in all wells. It makes its appearance with, or soon after, the initial production. The average gravity of the oil is 38.6° A. P. I. The field has produced a total of 6,504,319 barrels: an average yield per acre of 15,125 barrels, and an average yield per well of 144,540 barrels (Fig. 12).

Simpson formation.—Simpson production is found in a sandstone near the base of the formation. The oil zone is approximately 10 feet in thickness and has a porosity of about 8 per cent. This formation has not been greatly exploited at this time. Eight wells, however, located on the east flank of the structure, have been completed as commercial producers, and other wells with less favorable structural positions have been drilled and showings of oil were found. The average gravity of the oil is 39.0° A. P. I. The formation to date has produced a total of 316,646 barrels of oil, an average recovery per well of 39,580 barrels.

ARTIFICIAL STIMULATION AND REJUVENATION

Acidization.—The use of muriatic acid has been very successful in stimulating and rejuvenating the production of the Viola limestone. Many newly drilled wells were treated with 1,000 gallons of acid before taking potential tests; likewise wells that are nearing their economic limit are similarly treated. One well was experimentally given a second treatment without success.

Figures 13 and 14 illustrate the reaction of acid on wells that have reached their economic limit and wells that have been treated after completion.

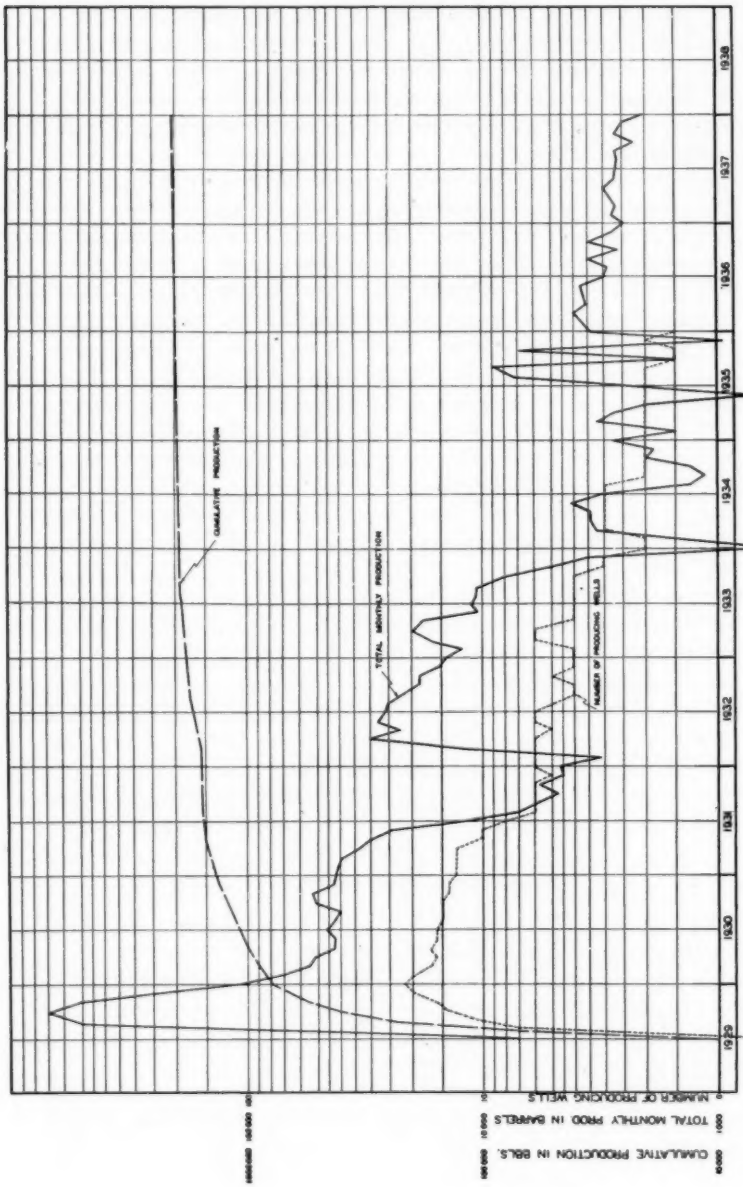


FIG. 11.—Production data, Mississippian limestone.

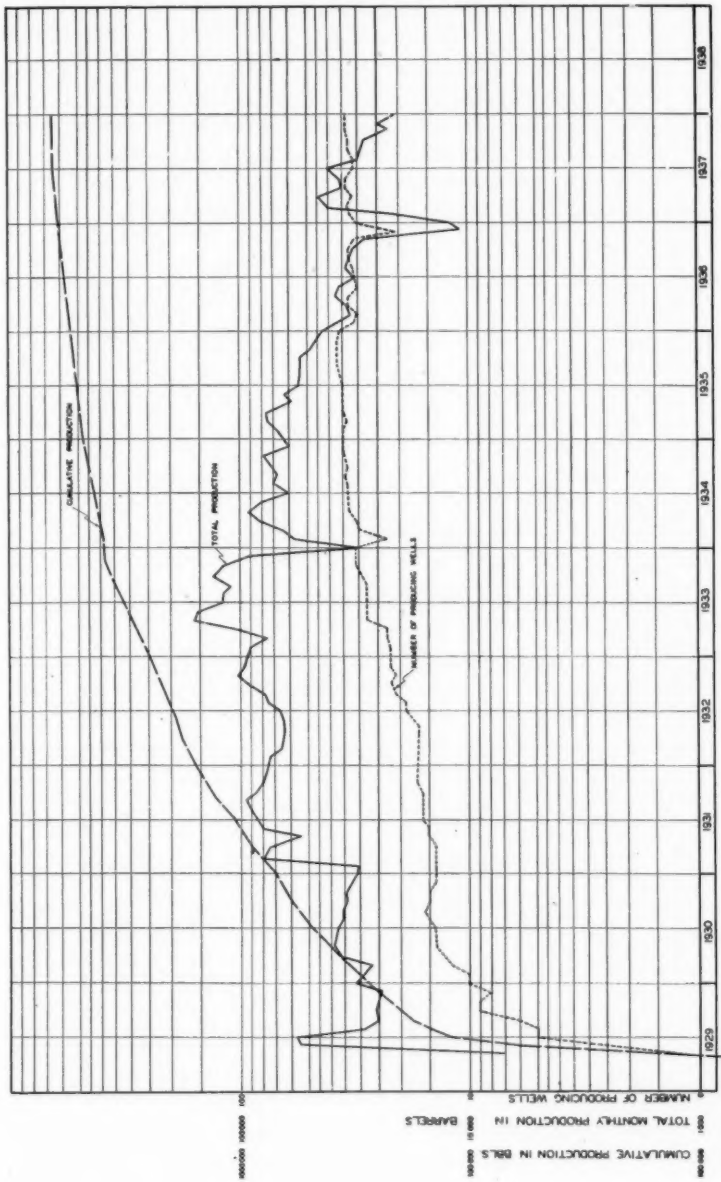


FIG. 12.—Production data, Viola limestone.

FIG. 13.—Increase of production by acidization, Viola limestone, P. F. Lygrisse "D" No. 1.

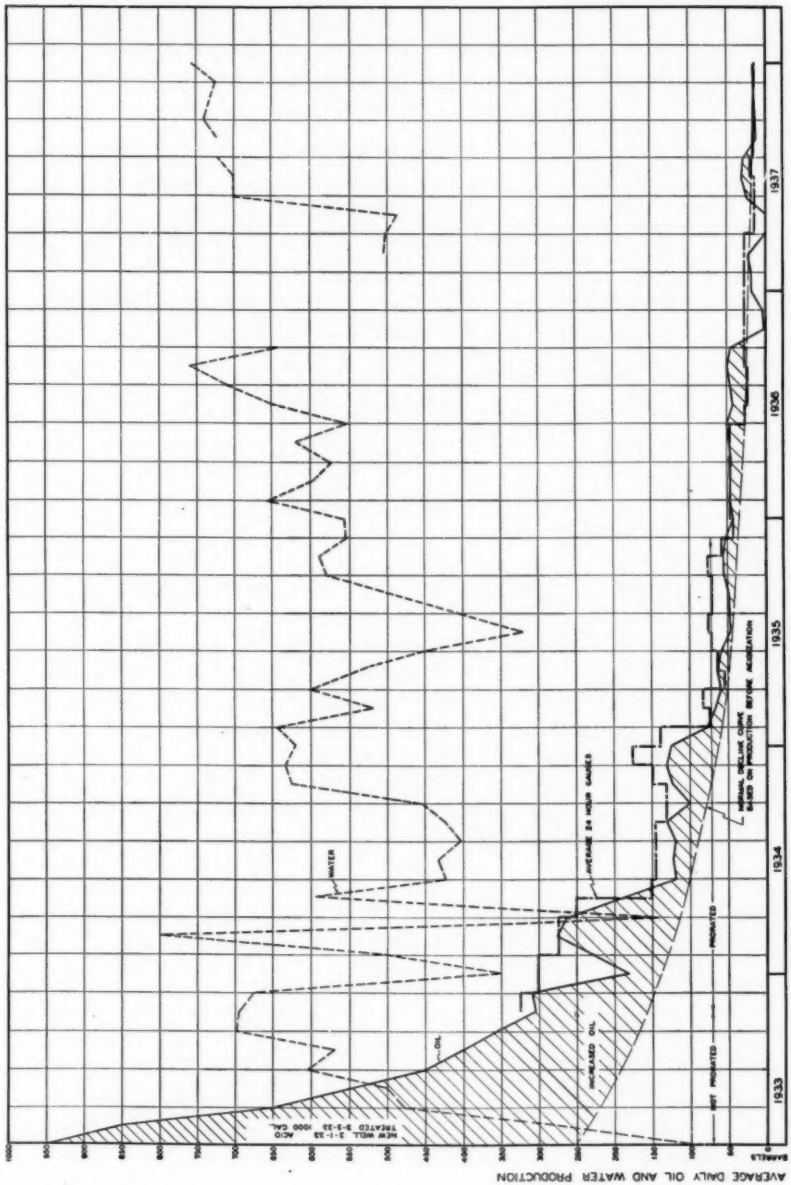


FIG. 14.—Increase of production by acidization, Viola limestone, P. F. Lygrisse "A" No. 5.

Shooting.—Simpson sand wells are generally shot with nitroglycerine in an attempt to stimulate production. The shooting makes it possible to obtain larger initial potentials and it appears that it will enhance the ultimate recovery of the wells.

WATER ENCROACHMENT

Mississippian limestone.—Edge water has encroached to all parts of the structure in the Mississippian limestone. Most wells have reached their economic limit and have been either abandoned, or deepened to lower zones.

Viola limestone.—A strong water drive is present in the Viola limestone. Water is found in all parts of the structure and is produced with the oil, regardless of the amount of penetration.

Extensive data on bottom-hole pressures have never been obtained. A pressure bomb was run in one well in 1933, and the following pressures were found to exist.

Depth (Feet)	*Pressure (Pounds/Inches²)*
1,000	270
2,000	623
3,000	960
3,130	1,025

It appears that the pressures have remained fairly constant as a result of the water drive. Moreover, it appears that water is replacing the oil almost as fast as it is extracted. This is based on the fact that the fluid level in all wells is about 550 feet below the surface; also at the time proration was inaugurated, the entire field was shut down for 30 days, and every well filled to the surface.

Simpson formation.—A very small amount of water is present in the Simpson formation. Wells that had produced for a period of 3 years had a water content of less than $7\frac{1}{2}$ per cent.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 23, NO 5 (MAY, 1939), PP. 663-685, 12 FIGS.

NEW MATHEMATICAL AND "STEREOGRAPHIC NET" SOLUTIONS TO PROBLEM OF TWO TILTS—WITH APPLICATIONS TO CORE ORIENTATION[1]

CURTIS H. JOHNSON[2]
Santa Monica, California

ABSTRACT

After an introductory discussion of the two-tilt problem and of similar problems in the new art of magnetic core orientation, four fundamental equations for solving these problems in terms of two new parameters are derived. The use of these equations in constructing nets for the solution of the problems under discussion is described, and it is shown that these new equations are the basis of the stereographic-net solution recently described in this *Bulletin* by D. Jerome Fisher. After a discussion of the use of Fisher's stereographic-net method in cases of overturn of the beds, a new method of employing the stereographic net is described which, while generally applicable, is particularly useful in cases of overturn.

When cores are magnetically oriented by the method of Lynton, an orientation correction and a strike-and-dip correction are necessary when the cores are from non-vertical holes. These corrections are briefly described, and their solution by the methods of the first part of this paper is illustrated.

The problem of determining the original dip of beds below an angular unconformity from the present dip of the beds above and below the unconformity has long been a subject for discussion. One of the earliest writers to consider the problem was Harker,[3] whose graphical and mathematical solutions have, until recently, been cited as references,[4,5] though more recently Spieker[6] has shown that Harker's solution is valid for a special case only.

Since Harker, other mathematical solutions have been published, that by Mertie[7] probably resulting in the simplest equations. However, in the opinion of the writer, none of these solutions lends itself to rapid computation as well as the solution developed herein.

Recently Fisher[8] has described several solutions employing the stereographic net and the stereographic projection, and has pointed

[1] Manuscript received, November 24, 1938.

[2] 1136 Franklin Street.

[3] A. Harker, "Graphical Methods in Field Geology," *Geological Magazine*, Vol. 1 (3) (1884), pp. 154–62.

[4] D. Jerome Fisher, "Some Dip Problems," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 21, No. 3 (March, 1937), pp. 340–50.

[5] Kenneth W. Earle, *Dip and Strike Problems* (London, 1934), pp. 116–17.

[6] Edmund M. Spieker, "Problem of Two Tilts—Harker's Solution Corrected," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 22, No. 9 (September, 1938), pp. 1255–60.

[7] J. B. Mertie, Jr., "Analysis of Structure Below an Unconformity," *Econ. Geol.*, Vol. 17 (1922), pp. 572–74.

[8] D. Jerome Fisher, "Problem of Two Tilts and the Stereographic Projection," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 22, No. 9 (September, 1938), pp. 1261–71.

out the similarity of the two-tilt problem to the problems of polarizing microscopic research, X-ray diffraction patterns of crystals, and navigation by astronomical observations.

In 1927 and 1928 Herrick[9] and Lynton[10,11] began the development of the method of core orientation based on measurement of the magnetic polarity impressed on the cores by the earth's magnetic field and retained by them after their removal to the surface. In the following decade, Lynton has developed the method to the point where it is commercially practical, and at the present time a core-orientation service employing this method is offered by the Sperry Sun Well Surveying Company.

In obtaining true dips from oriented cores, it is necessary to correct the observed magnetic orientation for errors introduced by the combination of the dip of the earth's magnetic field and the deviation of the bore hole from the vertical. It is then necessary to correct the "apparent" dip of beds as observed in the core for errors introduced by the deviation of the bore hole from the vertical.

Lynton recognized the need for the latter correction, and in his first article on magnetic core orientation[10] described a relatively rapid mechanical solution worked out by himself, together with a mathematical solution developed by E. L. Ickes of the Western Gulf Oil Company, with which "about an hour" was required to solve the problem—"even with a calculating machine." Recently Lynton has employed a very simple vector method, which he recognizes as being accurate at small angles only.[12]

At present the need for the first correction is also recognized,[13] though the writer has seen no account of its solution.

In this paper a new mathematical solution to the problem of two tilts is developed, solutions by means of the stereographic and other nets are discussed, and the application of these methods to the problems of core orientation is demonstrated.

I. A NEW MATHEMATICAL SOLUTION

In setting up the equations in a problem of this kind both the methods of solid geometry and of spherical trigonometry may be, and

[9] H. N. Herrick, "Method of and Apparatus for Determining the Direction of the Dip and Strike of the Earth's Sub-Strata," U. S. Patent No. 1,792,639, issued Feb. 17, 1931.

[10] Edward D. Lynton, "Laboratory Orientation of Well Cores by Their Magnetic Polarity," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 21, No. 5 (May, 1937), pp. 580–615.

[11] Edward D. Lynton, "Recent Developments in Laboratory Orientation of Cores by Their Magnetic Polarity," *Geophysics*, Vol. 3, No. 2 (March, 1938), pp. 122–29.

[12] Edward D. Lynton, personal communication, July, 1938.

[13] G. L. Kothny, personal communication, October 1, 1938.

have been, used. To reduce the derivation to the most elementary terms, the writer has chosen the solid geometry approach.

The problem may be stated as follows: given any plane of known orientation (dip and strike, or dip and azimuth of dip), to rotate the plane through a known angle about a known horizontal axis, and then to determine its new orientation.

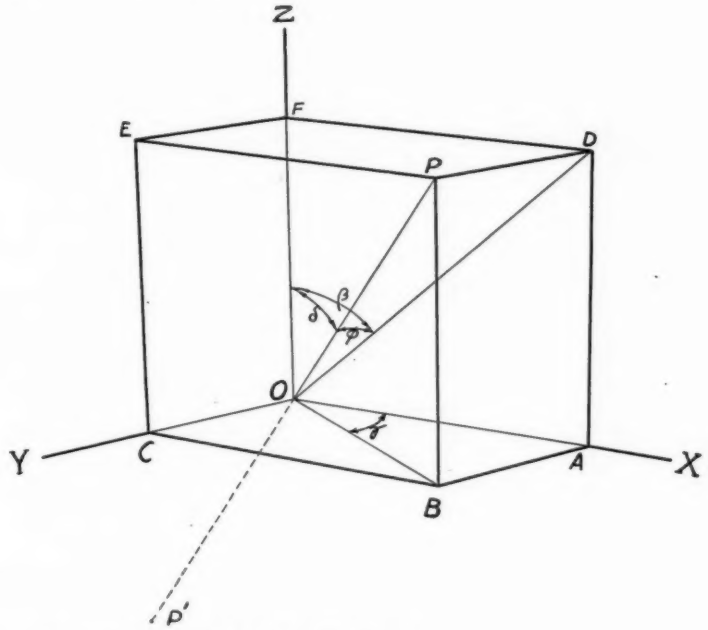


FIG. 1.—OP=normal to beds. OC=axis of tilt.
δ=true (total) vertical angle of dip.
β=component of δ in plane normal to axis of tilt.
γ=azimuthal angle between direction of dip and a normal to tilt axis.
ϕ=component of γ in plane of dip-normal and axis of tilt.

In Figure 1 a left-handed Cartesian coördinate system is shown, with the XY plane horizontal and the Z axis positive upward. The Y axis is chosen to coincide with the axis of secondary tilt, and the positive direction of the X axis is taken in the direction of the secondary tilt.

The bedding plane is considered to pass through the origin of coordinates, and at the origin an upward-directed plane normal, OP, of unit length, is erected.

The parallelepiped, *OABCFDPE*, with sides parallel, or coinciding with the coördinate planes, is constructed on *OP* as a diagonal.

The direction of dip, *OB*, as customarily projected on the horizontal plane, is defined by the angle, *AOB*, or γ, which it makes with

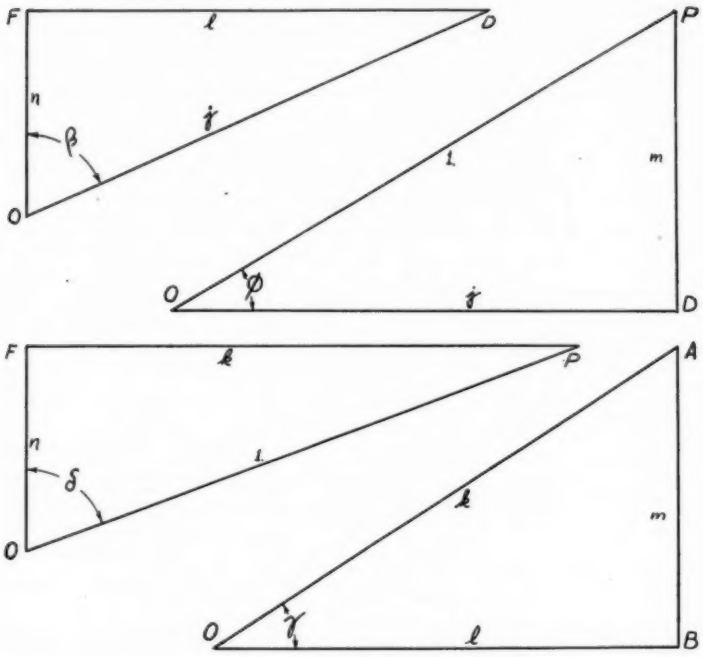


FIG. 2.—Key triangles of Figure 1 used in derivation.

OX, the direction of secondary tilt. Angle *POF*, or δ, is the amount of the total dip.

Two other angles are employed in the present solution to the problem. They are β, the dip component in the *XZ* plane, and ϕ, the complement of the angle between the axis of tilt and the plane normal. When tilt occurs, ϕ remains constant[14] and β varies by the amount of the tilt.[15]

[14] W. A. Dalton, "Geological Problems," *Geological Magazine* (1873), p. 322, assumed the dip component in the vertical plane containing the axis of tilt remained constant during the tilting, whereupon Harker, *op. cit.*, p. 155, lamented, " . . . it is erroneously assumed that the inclination of the strata at right angles to that of the second tilt is unaltered by the tilting." Earle, *op. cit.*, recognized the invalidity of this assumption for large angles, yet in calculating an example by an approximate formula

Evidently the sides of the parallelepiped of Figure 1 are the direction cosines of the normal (OP) to the bedding plane.

Following the usual convention for direction cosines:

$$l = OA = FD = EP = CB$$
$$m = OC = AB = DP = FE$$
$$n = OF = AD = BP = CE$$

It is also useful to define certain other lines in the figure.

Let $k = OB = FP$

$j = OD$

To show clearly which angles in the figure are right angles, certain key triangles have been reproduced in Figure 2. In these triangles the following relations may be observed.

	Sin	*Cos*	*Tan*
δ	k	n	k/n
β	l/j	n/j	l/n
γ	m/k	l/k	m/l
ϕ	m	j	m/j

From the foregoing table we may write down at once the following four fundamental equations.

$$\text{Cos } \delta = \text{Cos } \beta \cos \phi \tag{1}$$
$$\text{Sin } \phi = \text{Sin } \gamma \sin \delta \tag{2}$$
$$\text{Tan } \beta = \text{Tan } \delta \cos \gamma \tag{3}$$
$$\text{Tan } \phi = \text{Tan } \gamma \sin \beta \tag{4}$$

These equations express any one of the four variables, δ, γ, ϕ, or β, in terms of any two of the others. Furthermore, since ϕ is a constant during tilting and β is varied by exactly the amount of the tilt, ϕ and β are the logical parameters in terms of which to express δ and γ. This fact has apparently not been recognized by earlier writers as far as the present writer has been able to ascertain.

Without recourse to graphs or nets of any kind these equations may be employed to calculate the change in the amount and direction of dip as a result of tilting. In using these equations it is convenient to designate the values of the variables before tilting with the subscript 1 and those after tilting with the subscript 2. Since ϕ remains constant during tilting, $\phi_1 = \phi_2$.

---

involving this assumption, he chose angles so large that his result is in error by 2° in dip and 1½° in strike, though his answer is given to minutes.

[15] The truth of the statements of this paragraph should be apparent. However, anyone interested in proving the statements will find it an easy exercise in solid geometry.

From the original δ_1 (dip) and γ_1 (direction of dip) the parameters ϕ_1 and β_1 may be calculated by means of equations (2) and (3). After tilting the parameter ϕ_1 remains the same, while the parameter β_1 becomes $\beta_2=\beta_1+\Delta$, where Δ is the amount of the tilt. The values of δ_2 (dip) and γ_2 (direction of dip) after tilting may then be calculated from equations (1) and (4), using β_2 in place of β_1.

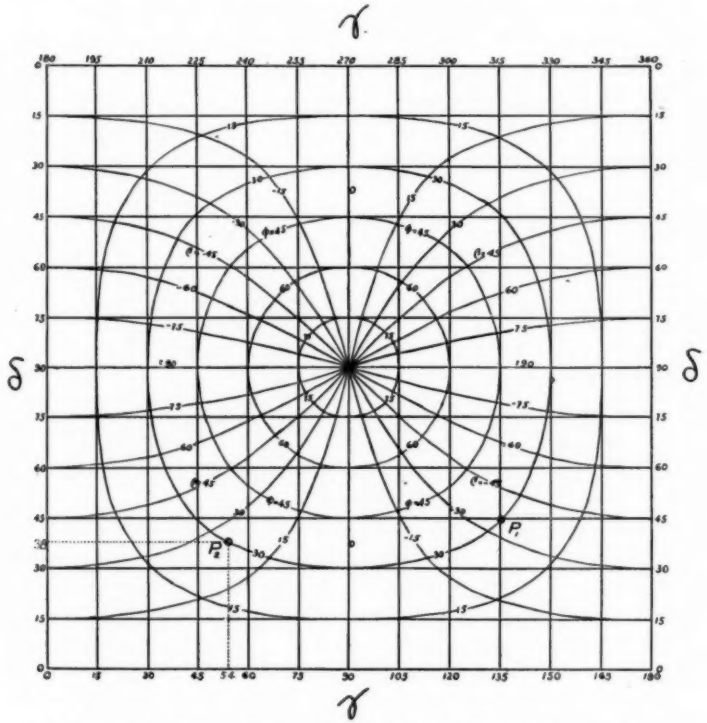


FIG. 3.—Cartesian coördinate net plotted from the fundamental equations for solving the two-tilt and allied problems.

In the conventional two-tilt problem the procedure is the reverse of the preceding paragraph. From the present δ_2 (dip) and γ_2 (direction of dip) the parameters ϕ_2 and β_2 may be calculated by means of equations (2) and (3). Before the tilting, the parameter ϕ_2 was the same, while the parameter β_2 was $\beta_1=\beta_2-\Delta$. The values of δ_1 (dip) and γ_1 (direction of dip) before tilting may be calculated from equations (1) and (4), using β_1 in place of β_2.

II. RELATION BETWEEN MATHEMATICAL SOLUTION AND FISHER'S[16] STEREOGRAPHIC NET SOLUTION

The relationship between the above four equations and the stereographic and other nets may now be shown. Evidently from equation (2) we may plot, on Cartesian or any other coördinates, δ as a function of γ for various values of ϕ. We thus obtain a family of curves relating δ and γ with the parameter ϕ constant along any one curve. From equation (3) we may plot a similar family of curves relating δ and γ with the parameter β constant along any one curve. If we plot both of these families of curves we have a characteristic "net." In Figure 3 such a net on Cartesian coördinates is shown plotted for every 15° in δ, γ, ϕ and β.[17] δ, β, and ϕ are plotted from $-90°$ to $+90°$ and γ from 0° to 360°.

This type of net may be used to solve the two-tilt problem as follows.

From the present dip, δ_2, and the present direction of dip, γ_2, locate the values of ϕ_2 and β_2 on the net. Subtract Δ, the amount of tilt, from β_2 to obtain β_1. From ϕ_2, and β_1 locate the values of the original dip, δ_1, and direction of dip, γ_1, on the net.

For example, suppose the dip of the lower beds after tilting is $\delta_2 = 38°$, the amount of tilt (or present dip of the upper beds) is $\Delta = 60°$, and the azimuthal angle between the present direction of dip of the lower beds and the direction of tilting is $\gamma_2 = 54°$: what was δ_1, the dip of the lower beds before tilting, and what was γ_1, the azimuthal angle between the direction of this dip and the direction of tilting?

Locate the point P_2 on the net of Figure 3 corresponding with $\delta_2 = 38°$ and $\gamma_2 = 54°$—at which point $\phi_2 = 30°$ and $\beta_2 = 25°$. Subtract $\Delta = 60°$ from $\beta_2 = 25°$ obtaining $\beta_1 = -35°$. Locate the point P_1 on the net corresponding with $\phi_2 = \phi_1 = 30°$ and $\beta_1 = -35°$—at which point $\delta_1 = 45°$ and $\gamma_1 = 135°$. Points P_2 and P_1 are shown on the net of Figure 3.

If γ and δ are chosen as the angular and radial coördinates respectively of a polar coördinate system, and the families of curves representing constant ϕ and β are drawn, another form of net results. In Figure 4 this net is drawn to 15° intervals. With fine enough graduations, this net may be used to solve the two-tilt problem by following the foregoing directions for the net of Figure 3, or by following the directions given by Fisher for solving the problem with the aid of the stereographic net.

[16] For any reference to "Fisher" in this section, see footnote 8.

[17] This net to 1° intervals, developed by the writer for a different purpose, is shown in: S. M. Rock, "Three Dimensional Reflection Control," *Geophysics*, Vol. 3, No. 4 (October, 1938), pp. 340–48.

It is but a short step from the polar coördinate net of Figure 4 to the stereographic net. In fact, if we choose γ and δ as the longitude and latitude coördinates on the polar stereographic net, and plot the families of curves for constant ϕ and β, we find that β and ϕ become respectively the longitude and latitude coördinates on the superim-

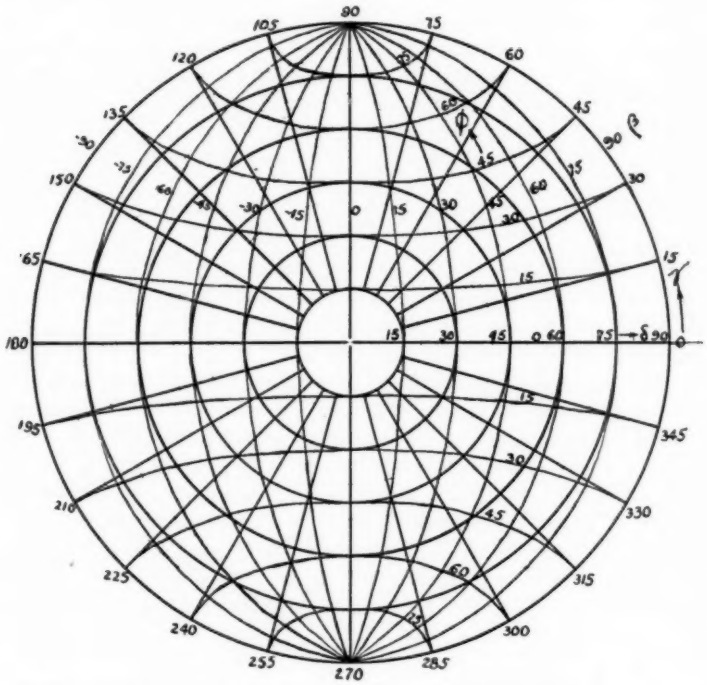


FIG. 4.—Polar coördinate net with δ as radial coördinate and γ as angular coördinate.

posed meridional stereographic net. These superimposed nets are shown in Figure 5, where, as in Figures 3 and 4, the variables are plotted at 15° intervals.

Fisher shows separately the polar and meridional stereographic nets drawn to 2° intervals,[18] and describes how the polar net may be

[18] C. S. Barrett lists many sources of stereographic nets, some graduated to 1° intervals, in a footnote on page 35 of "The Stereographic Projection," *Trans. Amer. Inst. Min. Met. Eng.*, Vol. 124 (1937), pp. 29–58.

dispensed with if a piece of transparent material be placed on top of the meridional net and pivoted at its center.

In the example of a solution of the two-tilt problem given by Fisher on pages 1262–66 of his paper, he essentially locates the intersection δ_2, γ_2 on the polar net, then moves along a constant ϕ line on the

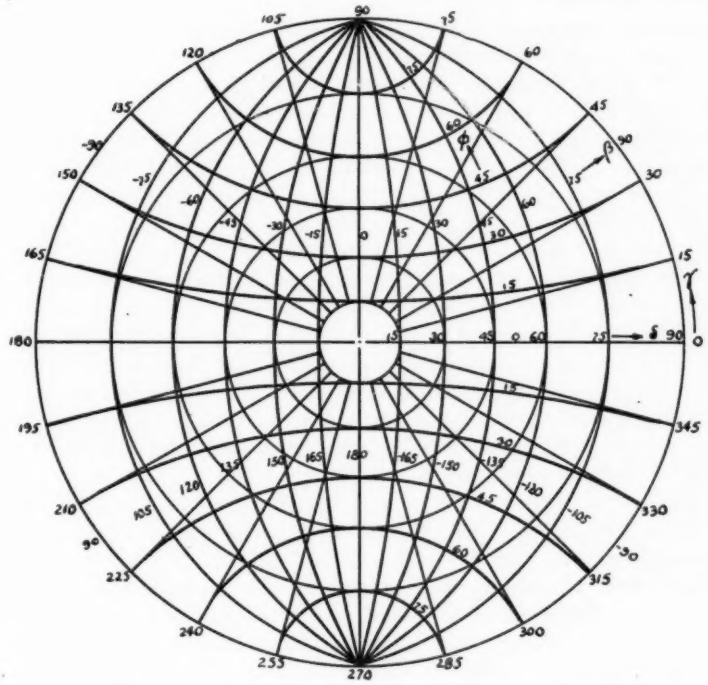


FIG. 5.—Stereographic net corresponding to polar coördinate net of Figure 4,—and as used by Fisher.

meridional net by the amount of the tilt (thus subtracting Δ from β_2) to locate the intersection δ_1, γ_1 on the polar net, corresponding to the amount and direction of the dip before tilting.

Fisher does not explain one anomalous situation. Suppose when we move along the constant ϕ line by the amount of the tilt, Δ, we reach the edge of the net before the entire amount of the tilt has been laid out—what then is the procedure?

From Figure 5 it is evident that if the edge of the net is reached in

laying out the amount of the tilt, the dip component, β_2 minus Δ, has become minus 90°. If there is further tilt making the dip component in the direction of tilt greater than 90° in absolute magnitude, overturn of the beds has occurred regardless of the size of the dip component at right angles to the direction of tilt.

Two cases arise: first, lower beds, originally overturned may have been righted by the secondary tilt, and, second, lower beds may have been overturned as a result of the secondary tilt.

Under some circumstances there may be independent evidence as to which side of the lower beds was originally the top, thus determining which of the foregoing two cases is present. More often, such evidence is lacking, and the question of which of the two cases is present must be decided arbitrarily, or on the basis of the relative probability of the two. Under ordinary circumstances, there is little doubt that the second case is more probable than the first.

Thus, *if it be known in advance* that the succeeding calculation or graphical solution will result in a change to or from overturn of the lower beds, it should generally be assumed to be "*from* overturn" rather than "*to* overturn," and the present dip of the lower beds accordingly given a value greater than 90°, and a direction of dip opposite to its present apparent direction of dip. A solution by means of the equations of this paper, or by means of certain graphical procedures,[19] will then yield a dip less than 90° characteristic of the beds before being overturned by the secondary tilt.

However, *if it be known in advance* that the succeeding calculation or graphical solution will result in a change to or from overturn, and there is independent evidence that the lower beds are not now overturned, the present dip of the lower beds should be measured in the conventional manner. A solution by means of the equations of this paper, or by means of certain graphical procedures[20] will then yield a dip greater than 90° characteristic of the beds as originally overturned before being righted by the secondary tilt now visible as a dip of the upper beds.

In the preceding two paragraphs, the words "if it be known in advance" are italicized for a reason. Since the original dip of the lower beds generally has a different strike from that of the secondary tilt, it is very difficult to predict in advance of the calculation, or graphical solution, whether or not a change to or from overturn will occur. Standardization of the procedure is thus difficult. For this reason the

[19] A graphical solution to this more probable case is the reverse of that of footnote 20.

[20] D. Jerome Fisher, discussion following this paper.

writer prefers to measure all dips on what is now the upper face of the beds (less than 90°). The answer will thus refer to the upper face of the beds as they were laid down—in the more probable case. Only in the less probable case will the answer refer to the lower face of the beds as they were originally laid down.[21] Essentially the writer's preferred method consists in changing the side of the bed to which the dip refers whenever the dip would exceed 90° if this were not done.

Though in this paper the attitudes of the beds are described in terms of their strikes and dips, it is convenient to return to the "normal to the bed" nomenclature and to Figure 1 to visualize how the amount and direction of dip vary when overturn occurs and the reference face of the bed is simultaneously changed. For this purpose the concept of the negative direction of the normal to the bed is used. Similarly, the negative side of a bed refers to what was its bottom side at the time of deposition.

Evidently when OP, the normal to the bed, rotating about the Y axis, approaches the surface, or XY plane, from above in the front upper right-hand octant of space shown in Figure 1 (corresponding with the dip component β approaching 90°) OP' representing the negative direction of the normal to the beds, approaches the surface from below in the lower rear left-hand octant of space. As the point of overturn is passed, OP' rises into the upper rear left-hand octant of space. Evidently then, the dip of the negative side of the overturned beds decreases from 90° following overturn, while the direction of this dip is in the opposite azimuthal quadrant from that of the non-overturned beds.

Thus, if the edge of the net of Figure 5 is reached before the entire amount of the tilt has been laid out, the remainder may be laid out in the opposite quadrant, beginning at the edge of the net and moving inwardly on the same constant ϕ line. This operation is shown schematically in Figure 6. The resultant dip and direction of dip read from the net will, of course, refer to the negative side of the beds if the original measurements were made upon the positive side, and will refer to the positive side of the beds if the original measurements were made upon the negative side.

This condition of overturn may be treated another way, since the nature of the stereographic projection is such that more than one hemisphere can be represented. Thus the longitude and latitude lines in both the polar and the meridional nets may be extended to include

[21] For the less probable case, the answer may be changed to refer to the opposite face of the beds by using the supplement to the calculated dip, and its reverse direction.

a part, at least, of the region corresponding with overturned beds. This expedient, however, is not very practical, for though several writers[22] have given data for constructing such extended nets, there are, to the writer's knowledge, no such nets available commercially. Furthermore, it is impractical to construct such nets beyond about 150° due to the space required.

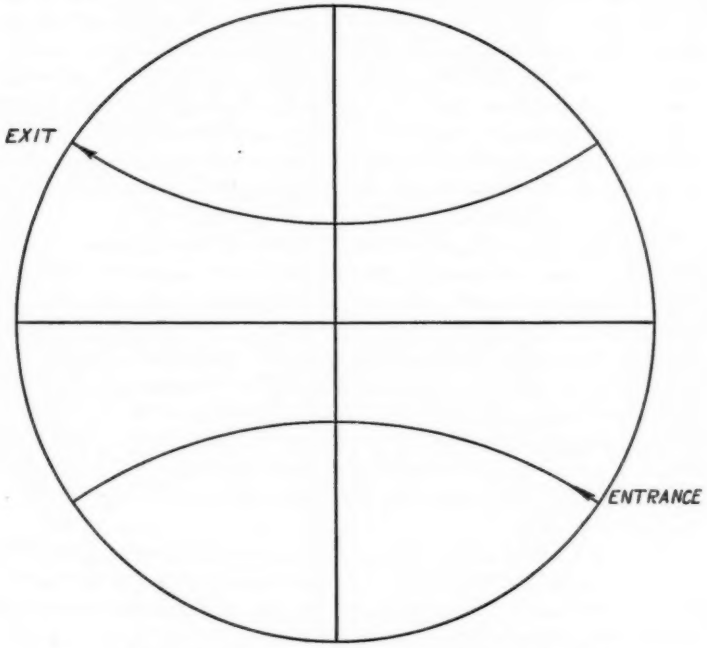


FIG. 6.—Schematic representation of method of employing net of Figure 5 in cases of overturn of beds due to secondary tilt.

III. A NEW STEREOGRAPHIC NET SOLUTION

In an effort to avoid the technique of Figure 6, and yet remove the necessity, in the most common cases, of measuring or calculating dips on the under sides of beds, the writer has developed the following new stereographic net solution which indicates at a glance when overturn has occurred, and yet yields a corrected dip, never exceeding 90°, as conventionally measured on the upper face of the beds.

[22] See, for example, S. L. Penfield, "Stereographic Projection," *Amer. Jour. Sci.*, Vol. 11 (1901), pp. 1–25.

As has been pointed out herein, any two of the four variables related by equations (1) to (4) may be considered as the independent variables. Thus let us plot a polar coördinate net similar to that of Figure 4 but with β and $90°-\phi$ as the angular and radial coördinates respectively. On such a net the longitude lines in the meridonial net

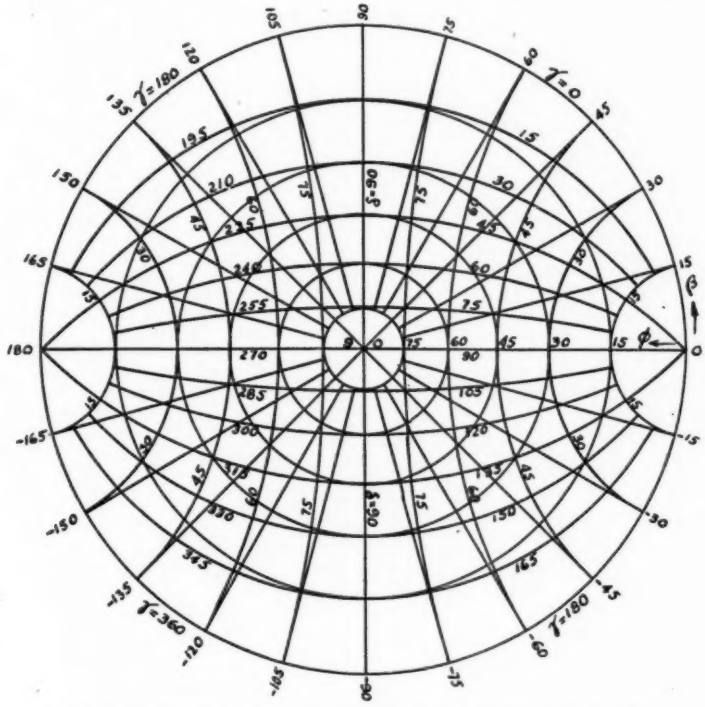


FIG. 7.—Stereographic net with ϕ as latitude and β as longitude in polar net and δ as latitude and γ as longitude in meridional net.

will be the constant γ lines while the latitude lines in the meridional net will be the constant δ lines. This polar coördinate net is not here shown; instead let us pass directly to the corresponding stereographic net shown in Figure 7.

In Figure 7 the lines of constant ϕ, or the lines along which the tilt is laid off, are small circles in the *polar* stereographic net. Thus, regardless of the magnitudes of the other quantities involved, the tilt operation is a simple rotation, at uniform scale, about the center of

the meridional stereographic net. A transparent sheet rotatably pivoted at the center of the meridional stereographic net marked in γ and δ in the manner of Figure 7 will suffice to solve the two-tilt problem by three simple steps as follows.

1. Make a mark on the overlying transparent sheet at the intersection, γ_2, δ_2, these values being obtained from the strike and dip data after tilting, as already described herein.

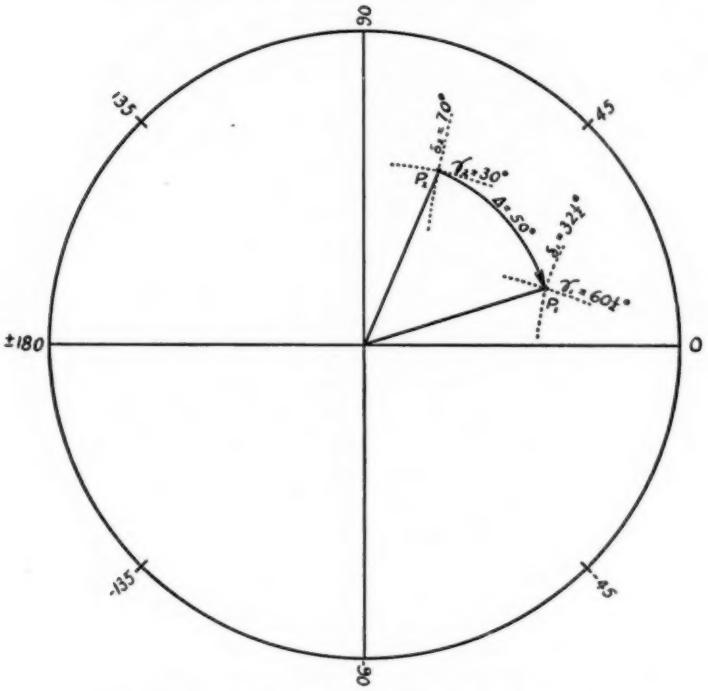


FIG. 8.—Example of two-tilt problem solved by net of Figure 7.

2. Rotate the mark clockwise through the angle Δ, the amount of the tilt.
3. Under the new position of the mark read the values of γ_1 and δ_1, before the tilt, these values being expressed as strike and dip as already described.

The equator on the meridional net may be called the "overturn line," for if the tilt-rotation operation here described places the

"mark" to the left of this line, overturn has occurred, and the values read from the net refer to beds that have been overturned. Thus it may be seen that this method of using the stereographic net is particularly convenient when overturn has occurred, and, due to the uniform tilt scale and the rotational method of applying the tilt, it may appeal to geologists under most circumstances.

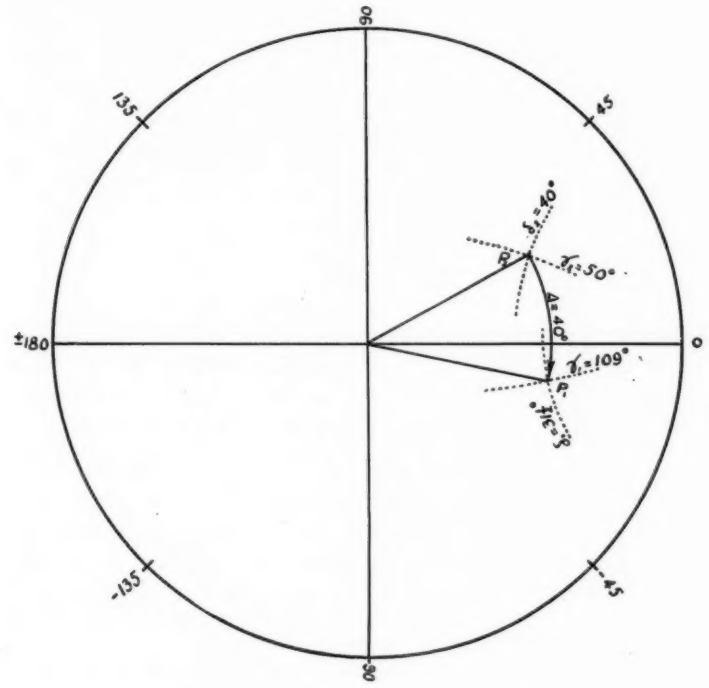


FIG. 9.—Example similar to that of Figure 8, except that two quadrants are involved.

An example of the new method of using the meridional stereographic net marked as in Figure 7 is here given.

Suppose the upper beds now dip 50° N. 17° E., and the lower beds now dip 70° N. 13° W.

Then $\gamma_2=30°$ (counterclockwise from N. 17° E.)

$\delta_2=70°$

$\Delta=50°$

As shown in Figure 8, the point $\gamma_2 = 30°$, $\delta_2 = 70°$ is first marked on the superimposed transparent sheet at P_2. The transparent sheet is then rotated (always clockwise) through the angle $\Delta = 50°$, placing the marked point at P_1 where $\gamma_1 = 60\frac{1}{2}°$ and $\delta_1 = 32\frac{1}{2}°$. Applying $60\frac{1}{2}°$ counterclockwise from N. 17° E. (as preceding), the original dip of the lower beds is found to be $32\frac{1}{2}°$ N. $43\frac{1}{2}°$ W.

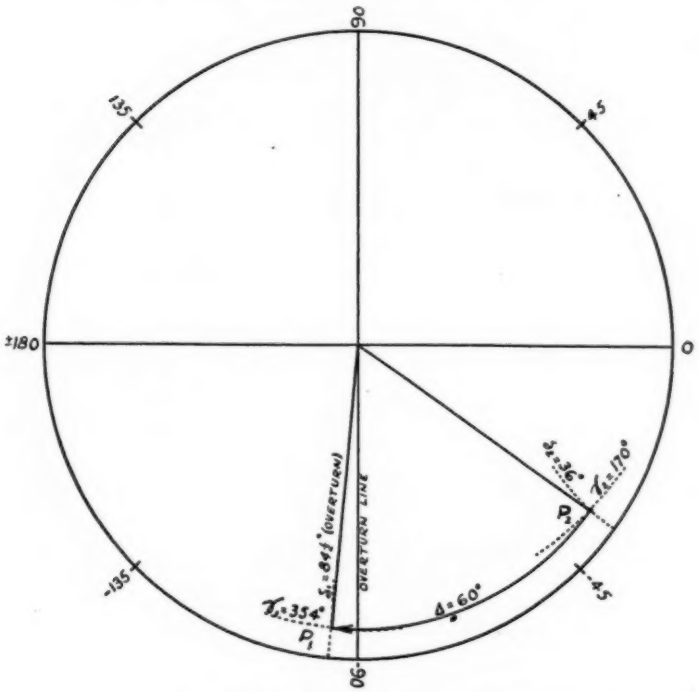


FIG. 10.—Example of use of net of Figure 7 in case of overturn of beds due to secondary tilt.

A second example, in which P_2 and P_1 lie in different quadrants on the net is shown in Figure 9.

Upper beds now dip 40° S. 24° W. and the lower beds now dip 40° S. 74° W.

Then $\gamma_2 = 50°$ (clockwise from S. 24° W.)
$\delta_2 = 40°$
$\Delta = 40°$

Locate point P_2 on transparent sheet at $\gamma_2 = 50°$, $\delta_2 = 40°$. Rotate through the angle $\Delta = 40°$ (always clockwise) to P_1 where $\gamma_1 = 109°$ and $\delta_1 = 31\frac{1}{2}°$. Then applying 109° clockwise from S. 24° W. (as preceding), the original dip of the lower beds is found to be $31\frac{1}{2}°$ N. 47° W.

A third example, in which the beds overturned when tilted, is shown in Figure 10.

Upper beds now dip 60° N. 37° W. and the lower beds now dip 36° S. 27° E.

Then $\gamma_2 = 170°$ (counterclockwise from N. 37° W.)
$\delta_2 = 36°$
$\Delta = 60°$

Locate point P_2 on transparent sheet at $\gamma_2 = 170°$, $\delta_2 = 36°$. Rotate through the angle $\Delta = 60°$ (always clockwise) to P_1 where $\gamma_1 = 354°$ and $\delta_1 = 84\frac{1}{2}°$ overturned. Then applying 354° counterclockwise from N. 37° W. (as preceding), the original dip of the lower beds is found to be $84\frac{1}{2}°$ (overturned) N. 31° W.

IV. APPLICATIONS TO CORE ORIENTATION

For the purposes of this paper, the sequence of steps in magnetically orienting cores and thereafter determining the amount and direction of dip of the beds therein may be described as follows.

1. The true direction and dip of the earth's magnetic field is determined (as by a dip compass).

2. The direction and amount of the deviation of the bore hole from the vertical is measured (assuming a well-surveying instrument independent of the earth's magnetic field is employed). For reasons that will appear the writer prefers to use the direction opposite to the direction of deviation of the bore hole. This may be called the direction of dip of the top of the core if the top of the core is assumed to be cut off perpendicular to the axis of the core. The amount of dip of the top of the core is, of course, equal to the amount of deviation of the bore hole.

3. The direction of the component of the earth's magnetic field transverse to the core is ascertained by one of the magnetometer methods described by Lynton[22] or by other methods now under development. It must be noted that this "direction" is measured in the plane of the top of the core—not in a horizontal plane.

4. The direction of dip of the top of the core is marked on the top of the core after calculating (from the data of tabulations 1 and 2 immediately preceding) the angle *in the plane of the top of the core*

[22] See footnotes 10 and 11.

between the direction of polarity (determined in tabulation 3, immediately preceding) and the direction of dip of the top of the core.[24]

5. The apparent direction and amount of dip of the beds in the core are measured with respect to the top of the core and to the direction of dip of the top of the core as established in tabulation 4.

6. From the data of tabulations 2 and 5 the true dip of the beds in the core is calculated.

The first calculation (that of tabulation 4) may be visualized in terms of the two-tilt problem as follows.

Let a. The amount of dip of the top of the core $=\Delta$ (corresponding with the present amount of dip of the beds above an unconformity)

b. The true amount of dip of the earth's magnetic field $=\delta_2$ (corresponding with the present amount of dip of the beds below an unconformity)

c. The true direction of the earth's magnetic field referred to the direction of dip of the top of the core $=\gamma_2$ (corresponding with the present direction of dip of the beds below an unconformity referred to the direction of dip of those above)

Then d. The apparent amount of dip of the earth's magnetic field referred to the top of the core as horizontal $=\delta_1$ (corresponding with the original amount of dip of the beds below an unconformity)

e. The apparent direction of the earth's magnetic field referred to the top of the core as horizontal and to the direction of dip of the top of the core $=\gamma_1$ (corresponding with the original direction of dip of the beds below an unconformity referred to the direction of dip of those above)

Thus the calculation of tabulation 4 is identical with the calculation of the original amount and direction of dip of beds below an angular unconformity in the problem of the two tilts. In the core orientation problem, however, the amount, δ_1, is not required and need not be calculated. With this difference the examples already shown for the two-tilt problem apply here.

The second calculation (that of tabulation 6) may be visualized in terms of two-tilt problem as follows.

[24] There is reason to believe that this calculation has been omitted and the corresponding angle in the horizontal plane used instead in much of the magnetic core orientation that has been done. There are no published accounts of a method of making this calculation and only the personal communication of footnote 13 to indicate that the need for the calculation is recognized.

Let a. The amount of dip of the top of the core $= \Delta$ (corresponding with the present amount of dip of the beds above an unconformity)

b. The true amount of dip of the cored beds $= \delta_2$ (corresponding with the present amount of dip of the beds below an unconformity)

c. The true direction of dip of the cored beds referred to the direction of dip of the top of the core $= \gamma_2$ (corresponding with the present direction of dip of the beds below an unconformity referred to the direction of dip of those above)

Then d. The apparent amount of dip of the cored beds referred to the top of the core as horizontal $= \delta_1$ (corresponding with the original amount of dip of the beds below an unconformity)

e. The apparent direction of dip of the cored beds referred to the top of the core as horizontal and to the direction of dip of the top of the core $= \gamma_1$ (corresponding with the original direction of dip of the beds below an unconformity referred to the direction of dip of those above)

In the problem of determining the cored dips the apparent values, δ_1 and γ_1, are measured (tabulation 5) and the dip, Δ, of the top of the core is known. Thus the calculation of tabulation 6 is just the reverse of the calculation occurring in the two-tilt problem.

Using the equations of this paper for the calculation of tabulation 6, ϕ_1 and β_1 are calculated from δ_1 and γ_1 by means of equations (2) and (3). Δ is then *added* to β_1 to yield β_2. Then δ_2 and γ_2 are calculated from ϕ_2 $(=\phi_1)$ and β_2 by means of equations (1) and (4).

Using the stereographic-net method of Figure 5, the amount of tilt is laid off to the right instead of the left—corresponding with the addition instead of the subtraction of Δ.

Using the new stereographic net method of Figure 7, P_1 is first located, then the rotation, Δ, is made counterclockwise, instead of clockwise, to locate P_2—corresponding with an addition instead of a subtraction of Δ.

The first two of the three examples of the use of Figure 7 for solving the two-tilt problem may be rephrased as follows to illustrate the use of Figure 7 for the calculation of tabulation 6.

Suppose the dip of the top of the core is 50° N. 17° E. (the hole deviation is 50° S. 17° W.), and the apparent dip of the beds in the core is $32\frac{1}{2}$° N. $43\frac{1}{2}$° W.

Then $\gamma_1 = 60\frac{1}{2}°$ (counterclockwise from N. 17° E.)
$\delta_1 = 32\frac{1}{2}°$
$\Delta = 50°$

In a manner directly opposite to that shown in Figure 8, the point $\gamma_1 = 60\frac{1}{2}°$, $\delta_1 = 32\frac{1}{2}°$ is first marked on the superimposed transparent sheet at P_1. The transparent sheet is then rotated (always counter-

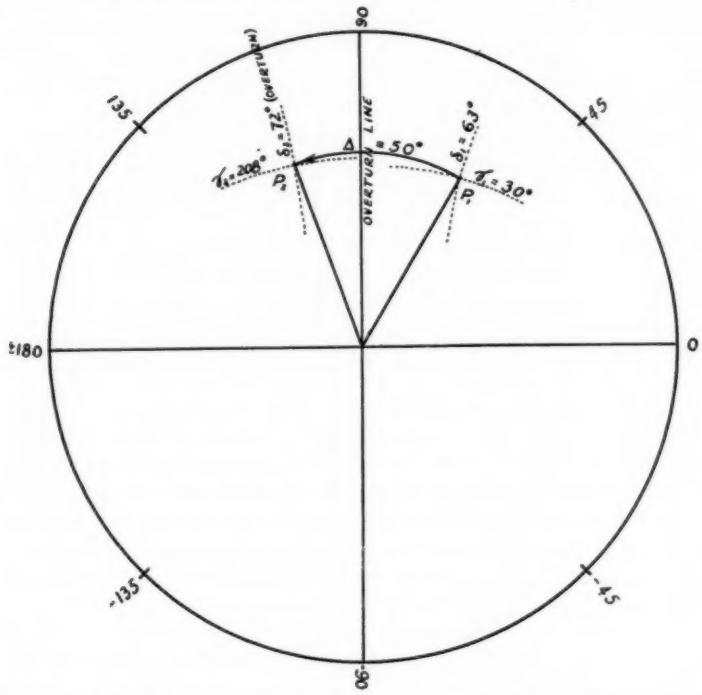


FIG. 11.—Example of use of net of Figure 7 in case of apparent overturn of beds in core due to deviation of bore hole from vertical.

clockwise) through the angle $\Delta = 50°$, placing the marked point at P_2 where $\gamma_2 = 30°$ and $\delta_2 = 70°$. Applying 30° counterclockwise from N. 17° E. (as preceding), the true dip of the beds in the core is found to be 70° N. 13° W.

In the second example, referring to Figure 9:

The dip of the top of the core is 40° S. 24° W. (the hole deviation is 40° N. 24° E.), and the apparent dip of the beds in the core is $31\frac{1}{2}°$ N. 47° W.

Then $\gamma_1 = 109°$ (clockwise from S. 24° W.)
$\delta_1 = 31\frac{1}{2}°$
$\Delta = 40°$

Locate point P_1 on the transparent sheet at $\gamma_1 = 109°$, $\delta_1 = 31\frac{1}{2}°$. Rotate through $\Delta = 40°$ (always counterclockwise) to P_2 where $\gamma_2 = 50°$ and $\delta_2 = 40°$. Then applying 50° clockwise from S. 24° W. (as preceding), the true dip of the beds in the core is found to be 40° S. 74° W.

A new example of overturn is shown in Figure 11.

The dip of the top of the core is 50° S. 22° E. (the hole deviation is 50° N. 22° W.), and the apparent dip of the beds in the core is 63° S. 8° W.

Then $\gamma_1 = 30°$ (clockwise from S. 22° E.)
$\delta_1 = 63°$
$\Delta = 50°$

Locate point P_1 on the transparent sheet at $\gamma_1 = 30°$, $\delta_1 = 63°$. Rotate through $\Delta = 50°$ (always counterclockwise) to the point P_2, where $\gamma_2 = 208°$ and $\delta_2 = 72°$ overturned. Then applying 208° clockwise from S. 22° E. (as preceding), the true dip of the beds in the core is found to be 72° overturned N. 06° E.

In conclusion, the writer hopes that added flexibility and breadth of application of the stereographic net have been contributed by this paper; that a simpler and more adaptable set of equations have been derived; and that new light has been thrown on the problems which arise as a result of deviations of bore holes from the vertical, in the art of determining the true values of dips in cores.

The writer wishes to thank D. Jerome Fisher for his critical reading of the entire paper, and particularly for his suggestions regarding Section II, many of which have been incorporated in the paper.

DISCUSSION

D. Jerome Fisher, University of Chicago (discussion received, January 2, 1939)

The methods of solid analytics involving direction cosines lead to an elegant derivation of the old equations for solving dip problems. Johnson's presentation is a lucid one, of interest to those who like mathematical proofs to back up graphical schemes. However, his interchange of parameters from polar to meridional stereographic nets and vice versa destroys the easy visualization of the method as outlined in my paper. He does this because of difficulty encountered when dealing with the relatively rare case of overturned beds. He correctly cites two methods of handling such beds when using the $\beta - \phi$ meridional stereographic net, but rejects both of them. There is a third

method, however, that is free from Johnson's objections, and since it has not been described, this may be worthy of brief note. In this method one distinguishes the upper from the lower half of the sphere by using different symbols. Thus the last problem given in Section III is solved as shown in Figure 12. *A* represents the pole of the lower beds (dip 36° to S. 27° E.) and *TT'* represents the tilt axis (strike of the upper beds N. 53° E.). Rotate the tracing

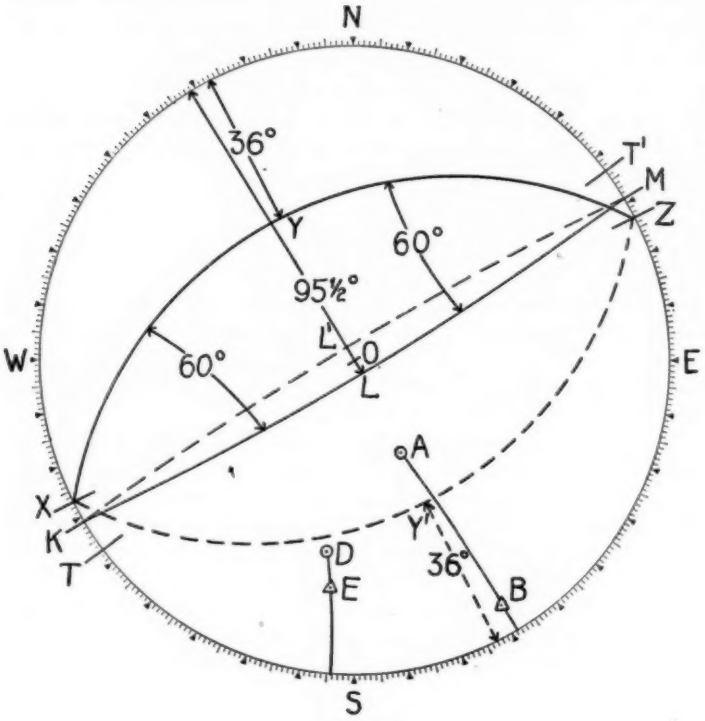


FIG. 12

paper till *TT'* lies above *NS* of the net (or more simply, do not plot *TT'*, but just rotate the tracing paper till its north point lies above net point N. 53° W. —complement of direction of dip of upper beds). Then from *A* go out along a small circle by 60° (dip of upper beds). 54½° carries one to the circumference of the net (equator); continue back on the same small circle (really going around on to the lower hemisphere) 5½° locating the point *B*, and surround it by a triangle to indicate it lies below the equator. This is the pole of a bed dipping 95½° to S. 31° E. as is easily read from the net when *B* is rotated above a diameter. In short, when the eye is located at the nadir of the sphere, the stereographic pole is surrounded by a circle; when at the

zenith, surround the pole with a triangle. The ease and speed with which this problem is here solved—by merely locating the point A and then counting 60° along the line AB—are not surpassed by Johnson's method. While the latter requires the plotting of but one point, it does involve two computations (each consisting of an addition or subtraction or two of them). Johnson's method is arithmetic-graphic, the writer's is geometric-graphic; the latter gives the visability of descriptive geometry in seeing each step of the process, thus removing any likelihood for error.

If planes are located by great circles (cyclographic projection) which represent the stereographic projection of the intersections of the planes with the spherical surface, this problem is solved entirely on one half of the sphere. Thus the original position of the lower beds, represented by continuous line arc XYZ if the eye be assumed at the nadir, is rotated 60° about TT' into continuous line arc KLM. The fact that the circular arc has flopped over the center O shows that the beds are overturned. If the cyclographic projection is used in this case with the eye at the zenith as advocated in my paper, then the dashed-line arc $XY'Z$ indicates the original position of the lower beds and the tilt sends this to the dashed-line arc $KL'M$. Here again the circular arc has moved across O, indicating overturning. Parenthetically it may be added that if one wished to pass a great circle through two points in the stereographic projection which points lie in upper and lower hemispheres, it is only necessary to use a diametrically opposite point in place of either one of the original points.[25]

Johnson's final problem is also shown in Figure 12. Point D represents the apparent dip of the beds in the core (63° to S. 8° W.). After plotting D the tracing paper is turned until its N point lies above N. 68° W. of the net (complement of the direction of deviation of the hole) and 50° (amount of deviation) is counted along a small circle [30½° to the circumference of the net (equator), then back 19½°], locating E which represents a plane dipping 108° to S. 6° W.

[25] The stereographic projection as applied to navigation-astronomy using geometric (construction) methods (rather than nets) is well covered in Bullard and Kiernan, *Plane and Spherical Trigonometry*, 240 pages; Heath and Company (1930), $2.00.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 23, NO. 5 (MAY, 1939), PP. 686-698, 4 FIGS.

GEOLOGICAL NOTES

FAIRBANKS AND SATSUMA FIELDS HARRIS COUNTY, TEXAS[1]

C. J. HARVEY[2] AND W. Z. BURKHEAD[3]
Houston, Texas

FAIRBANKS FIELD

The Fairbanks field was one of the most important field discoveries on the Texas Gulf Coast in 1938. Located in Harris County, approximately 15 miles northwest of Houston near the town of Fairbanks, it lies chiefly in the J. Waugh, G. Ayers, and J. Clarkson surveys.

As early as 1928, Fairbanks was recognized as a torsion-balance prospect. In late 1933 and early 1934, the area was shot with reflection seismograph by the Amerada Petroleum Corporation and the Stanolind Oil and Gas Company and a joint lease block assembled. Other principal lease holders are Union Producing Company, Sinclair-Prairie Oil and Gas Company, Skelly Oil Company, Smith and Ownby, Windsor Oil Company, Gem Oil Company, Bridwell Oil Company, Noble & Baker, and Williams & Thompson.

The Amerada Petroleum Corporation and the Stanolind Oil and Gas Company completed the discovery well, their E. W. Mills No. 1, on January 15, 1938, with an initial flow of 675 barrels of 38.8° gravity oil per day on a $\frac{1}{4}$-inch tubing choke. Tubing pressure was 1,100 pounds, casing pressure 2,500 pounds. The gas-oil ratio was 554. Drilled to a total depth of 6,863 feet with a 7-inch casing set at 6,859 feet, the well was perforated from 6,838 to 6,852 feet with 40 shots. The top of the producing sand was found at 6,787 (−6,666) feet, 14 feet below the top of the Yegua formation. The gas-oil contact was encountered at 6,834 (−6,713) feet and the oil-water contact at 6,860 (−6,739) feet, making an oil zone of approximately 26 feet.

From the standpoint of rigs in operation, Fairbanks has been one of the most active fields in the Gulf Coast. This active and rapid development resulted in the drilling of 130 producers, six dry holes, and one junked hole by January 1, 1939, proving for production thus far approximately 1,900 acres. The six dry holes have defined the field in all directions except the east and southeast. Cumulative pro-

[1] Manuscript received, March 27, 1939.

[2] Amerada Petroleum Corporation.

[3] Stanolind Oil and Gas Company.

duction to the end of 1938 is 848,490 barrels. The Texas Railroad Commission allowable for the field for January, 1939, is 6,518 barrels per day.

The structure on the main pay zones is that of a northeast-southwest trending anticline with a rather flat crest and relatively steep flanks. A closure of approximately 140 feet is indicated while the maximum effective closure (the interval between the water table and the top of the sand) thus far encountered is 111 feet. Faulting, though present in the Miocene and Oligocene section, is not evident in the Yegua or producing section. While accumulation is controlled primarily by structure, production is limited on the west in particular by gradation of porous sands to non-porous sands, sandy shale, and shales, thus making a sedimentary as well as structural trap.

All of the producing sands in the field are in the Yegua formation. This formation consists of approximately 1,000 feet of alternating sands and shales overlying the thick Cook Mountain shale section and underlying the thick Jackson shale section. The main producing zone is the "6,800-foot" sand which occurs 10–20 feet below the top of the *Eponides yeguaensis*, the top of the Yegua formation. All but five of the wells in the field are producing from this sand which has a maximum effective thickness of 90 feet on the top of the structure and thins by gradation off structure to a few feet of non-porous sands and sandy shale. This gradation is very abrupt. It is not exceptional for 50 feet of sand section to change so that the same section one location away contains only 10 feet of non-porous sand and sandy shale. The oil zone is 30–34 feet in thickness, and is overlain on most of the structure by a gas cap. In some of the highest parts of the structure, the entire sand section is in the gas cap. A thin sand approximately 100 feet above the "6,800-foot" sand has been cored in a few wells and found to contain gas and salt water. No completions have been attempted from this sand.

The "6,950-foot" sand is a minor producing zone, with two oil and two gas wells completed in it on the south flank of the structure. This sand appears to change to shale (updip) and coalesce with a large sand body downdip. Due to the irregularity of the sand and the thin oil zone, only a minor amount of production can be expected. A thin oil zone is found in the "7,200-foot" sand although the sand itself is approximately 140 feet thick. Of three wells drilled to this depth, two have recorded shows and one has been completed as a gas well. The "7,450-foot" gas sand, having a thickness of 15–20 feet, has been encountered in three wells and tested in one, but no wells have been completed in it. Two wells have been drilled to the Cook Mountain,

which is encountered at approximately 7,900 feet, without finding further showings.

Since the foregoing was written a new producing zone has been indicated at approximately 7,000 feet. The Union Producing Company's Murphy Unit No. 1, 2,100 feet northeast of production, had a good showing of oil on a drill-stem test in this zone and the Kirby Petroleum Corporation's C. E. Daniels No. 1 is now testing in the same sand. The latter well has extended the Fairbanks structure 6,000 feet northeast and is structurally the highest well in the field.

SATSUMA FIELD

Satsuma field lies along the strike and on the same structural trend with Fairbanks. It is located approximately 2½ miles southwest of the west edge of production at Fairbanks, and was discovered in June, 1936. The principal leaseholders are the Amerada Petroleum Corporation and the Stanolind Oil and Gas Company.

The discovery well, Amerada-Stanolind's Louis Dopslauf No. C-1, was completed producing 128 barrels of 44.8° gravity oil daily on a ¼-inch tubing choke, through casing perforations from 6,820 to 6,822½ feet. Production is from the equivalent of the "6,800-foot" sand as at Fairbanks. Although the two anticlines are apparently connected by a narrow "saddle," the reservoirs are separate. The effective oil zone is approximately 6,705–6,709 feet subsea. The maximum effective closure thus far encountered is only 40 feet. Because of the difficulty of completing wells in such a thin oil zone, development has been slow. To date, ten producing wells and two dry holes have been drilled. The cumulative production to January 1, 1939, was 264,325 barrels.

The Satsuma field has recently been extended 2,000 feet north by Williams, Thompson, and Gillespie's L. T. Behne No. 1, which was completed as an oil well in the equivalent of the "6,800-foot" sand at Satsuma but below the proved water level of the field.

OIL ON AGUA CALIENTE ANTICLINE DEPARTMENT OF LORETO, PERU[1]

R. G. GREENE[2]
Los Angeles, California

On February 26, 1939, the Compania de Petrolia Ganzo Azul, Ltd. (Blue Goose Oil Company) completed an oil well on the Agua

[1] Manuscript received, March 20, 1939.

[2] 422 West Sixth Street.

Caliente anticline, Department of Loreto, Peru. This area is located in the upper part of the Amazon River drainage system on the eastern flank of the Andean uplift, 300 miles north and 30° east of Lima.

Saturated sands totaling approximately 100 feet were tested in the interval from 1,021 to 1,174 feet. During the period from February 26 to March 9, the well produced a daily average of 750 barrels. On the last day of the production test, the quantity had increased to 1,008 barrels. Satisfactory tests of the character of this oil have not been made, but it is indicated that the gravity exceeds 50° A.P.I., and that it is of a paraffine base. The production test was made through a $\frac{5}{8}$-inch choke, and the flow was natural. Gas is practically absent and no pressures exceeding 20 pounds were recorded.

This oil occurs in what has been designated as the Agua Caliente formation which is well established as being of Lower Cretaceous age.

The Agua Caliente anticline was first observed by Robert B. Moran while carrying out an aerial reconnaissance in 1929 for the purpose of railway construction. Full credit for this discovery should, therefore, be accorded him. Additional credit is also due Douglas Fyfe, geologist, for an admirable example of detail work under more or less trying conditions, and to Glenn M. Earl, who served under him as engineer and assistant. This detail work was supervised by Moran. The anticline is on an eastward-dipping monocline which forms the east limb of the Andean uplift. The fold trends parallel with the strike of both this uplift and its attendant syncline on the east. In excess of 3,600 feet of closure has been mapped, and superimposed upon this structure are two local domes. The fold is slightly asymmetrical, and average dips are not in excess of 20°. The areal extent of this closure is not less than, and may exceed, 125 square miles.

Transportation of equipment and export of oil can be effected by utilization of Amazon River and one of its principal tributaries, the Ucayali, as far west as Iquitos for ocean-going shipping; thence by lesser draft by way of the Ucayali and Pachitea rivers. The area is also accessible by means of an air line operated by the Peruvian Government.

This discovery is of particular importance to those who are interested in foreign development and especially so to those who have been interested in exploration throughout South America. Briefly, the Amazon River, as far west as the Peruvian-Chilean border, occupies a position which roughly follows the axis of a major geosyncline. A north-south geosyncline of similar magnitude apparently

occupies a position midway between the Andean uplift and the Brazilian shield. The junction of the axes of these two geosynclines is hypothecated somewhere in the vicinity of Iquitos. The general area lying just eastward of the Andean Cordillera and westward of the Brazilian shield is apparently that of a structural basin and offers an area of tremendous proportions to exploitation by those interested in new petroleum reserves.

OIL POSSIBILITIES IN SOUTHERN TURKEY[1]

CEVAT EYUP TASMAN[2]
Ankara, Turkey

The most important oil fields of Eurasia with production accounting for more than 95 per cent of petroleum produced in Russia, Rumania, Poland, Iran, and Irak bear close structural relation to the late Tertiary system of folding. They are situated in the forefront of the Himalaya-Alpine chain of mountains where thick Tertiary and late Cretaceous deposits have accumulated and folded during Alpine periods of earth movements. The folding has varied in intensity with the distance from the Carpathians, Caucasus Mountains, Zagros Ranges, and Toros Mountains as the case may be.

In Turkey this peri-Alpine zone begins with a west-of-northwest trend across from Zaho in Irak and extends from Diyaribakir in an approximate east-west trend to Adana and the Mediterranean Sea. This is a vast zone and requires considerable geological study supported by informational drilling taking many years before the optimum stratigraphic and structural conditions may be found combined to produce an oil field.

There is little doubt that the ancient Arabian table-land enters into the present boundaries of Turkey as evidenced by the presence of a well developed Cambro-Ordovician section west of Mardin. Here we find the Upper Cretaceous resting with an angular unconformity on the Paleozoic mostly composed of sandstones, with some shale, conglomerate and metamorphosed limestone. The sand grains of the sandstones are principally quartz. Trilobites, most of them fragmentary but some well preserved, may be found in the more argillaceous parts.

East and west of this ancient Arabian shield Paleozoic basins have permitted the accumulation of enormous thicknesses of sediments. The Alpine structural features have been superimposed on these

[1] Manuscript received, April 4, 1939.

[2] M. T. A. Petrol Grubu Direktorü.

Paleozoic land masses and their accompanying foredeeps. Within the eastern geosyncline are found the important fields of Bahreyn, Saudi Arabia, Iran, and Irak. The prospective areas of eastern Turkey fall in this category. Looking at a map showing the oil seepages of this part of the world[3] it may be observed that the trend of these seepages continues on a northwesterly direction in spite of the east-west trend of the Alpine structural system. This is taken to suggest that the Paleozoic trough maintained its northwesterly course.

West of the Arabian Plateau is the northern extension of the Great Rift Valley terminating at Marash. In the foredeep on the west, in the region of Adana, Tertiary deposition of more than 3,000 meters has been measured. In this western province we find the upper Red Sea oil fields and prospective areas of Turkey and Cyprus.

The geosyncline east of the Arabian Plateau contains Triassic petroliferous limestones with *Pseudomontis clarai* and Carboniferous bituminous beds with a productid fauna. The Paleozoic beds in the center are represented by the sterile quartz sandstones of Cambro-Ordovician. In the western foredeep also is a petroliferous Paleozoic section with *Productus* and *Spirifer*. On the other hand, though the eastern geosyncline contains marginal thick Miocene deposits in Iran and Irak, they become thinner in entering Turkey and disappear entirely in the Mardin latitude. Farther north in the latitude of Van, Upper Tertiary becomes evident once more. The western foredeep, besides having the marine Paleozoic, contains the very thick Tertiary section mentioned.

The structures, both in the eastern geosyncline around Tigris and the western foredeep around Adana, are considered to have prospects of finding oil. It is in these areas that geologic work and exploratory drilling is planned to be carried forward. The degree of intensity of the work will be directly proportional to the funds available for the purpose.

The drilling in the Mardin area so far has produced one dry hole of 1,327 meters. The second well which went to 940 meters encountered pockets of gas (one large enough to furnish fuel for boilers) and many signs of asphalt and viscous oil. With the idea of speeding the exploratory work a second rig was brought to the region. The third well is meeting with even more prolific showings of oil, while the fourth hole is being drilled simultaneously on the adjoining structure of Kerbent and is progressing normally without the vexing drilling difficulties which characterized the well No. 1 at Basbirin and well No. 2 at Hermis.

[3] Djevad Eyoub, "Petroleum Possibilities of Turkey," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 15, No. 6 (June, 1931), p. 630, Fig. 1.

DORA POOL, SEMINOLE COUNTY, OKLAHOMA[1]

W. I. INGHAM[2]
Tulsa, Oklahoma

During the last 3 or 4 years there has been an extensive development of new pools in the "Seminole area" producing from Pennsylvanian sands. Of these the Dora pool is one of the most prolific. This pool is in Secs. 27, 28, 29, 32, 33, and 34, T. 7 N., R. 6 E., and Secs. 3, 4, and 5, T. 6 N., R. 6 E., Seminole County, Oklahoma.

The Shaffer Oil Company completed McCann well No. 1 in the NE. corner of Sec. 33, T. 7 N., R. 6 E., on July 2, 1929. This well was drilled 3,338 feet deep to the Cromwell sand where it found salt water. It was then plugged back to 2,810 feet where an initial production of 32 barrels of oil per day was obtained from the "Dora" sand. This well is now known to have been the discovery well of the northeast extension of the present pool.

The discovery well of the Dora pool proper was drilled 6 years later by D. B. Malernee, his West No. 1, in the SE. ¼, SE. ¼, NW. ¼ of Sec. 33, T. 7 N., R. 6 E. This well was completed on October 2, 1935, with an initial production of 117 barrels of oil per day from the "Dora" sand, 2,934–2,959 feet deep.

Malernee and Shelton's Flowers No. 1 in SE. ¼, SW. ¼, SW. ¼ of Sec. 29, T. 7 N., R. 6 E., was drilled in July, 1936, to the second "Wilcox" sand, where salt water was encountered. It was then plugged back to 3,030 feet, and completed in the "Dora" sand in November, 1936, with an initial production of 80 barrels of oil and 80 barrels of water. This production instigated rapid development of the Dora pool.

The rocks on the surface across the Dora pool belong to the Vanoss formation, of the Pontotoc group of Pennsylvanian age. The Vanoss formation ranges in thickness from 250 to 520 feet, and consists of shales, arkosic sands, conglomerates and a few thin limestones. These strata strike approximately N. 30°E., and dip about 125 feet per mile N. 60° W. The scanty outcrops consist principally of conglomeratic cross-bedded sandstones, and are difficult to interpret.

The underground sequence of beds penetrated by the drill is shown on the columnar section (Fig. 1). This columnar section is composite, being derived by the writer from sample examination and from sample logs of the many wells in the pool.

[1] Manuscript received, April 8, 1939.

[2] Consulting geologist, 1339 South Detroit Avenue.

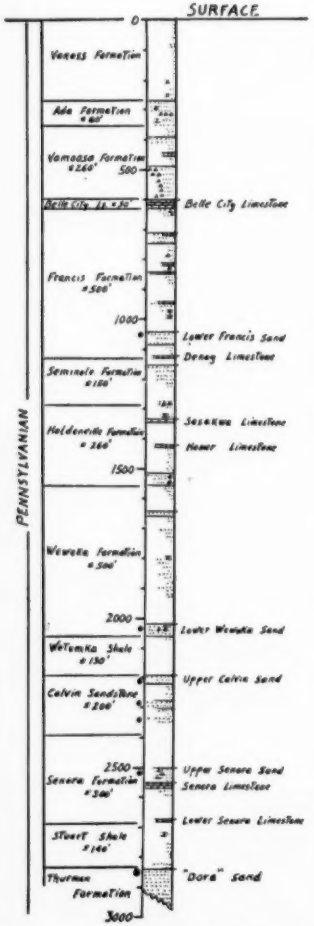


FIG. 1.—Generalized stratigraphic section, Dora pool. Thickness in feet.

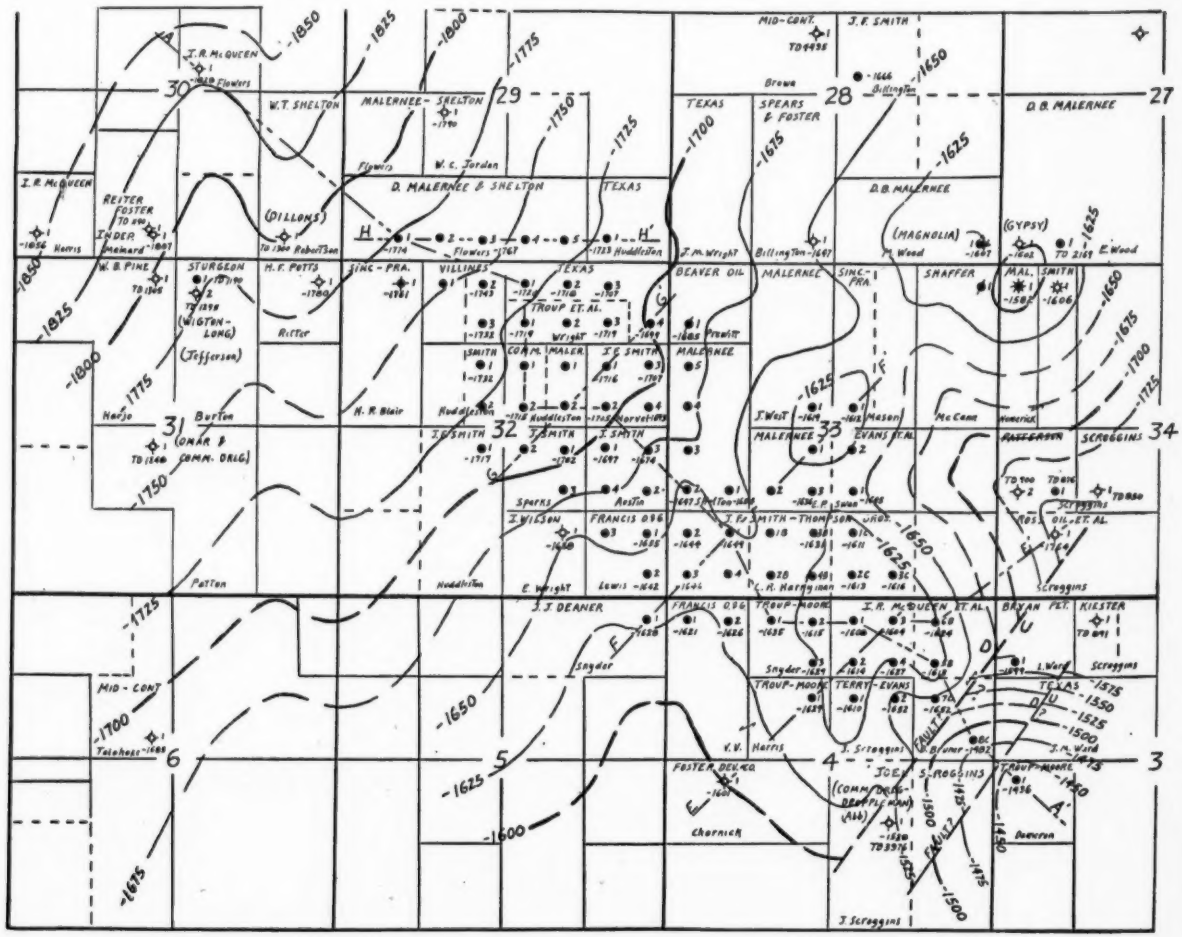


FIG. 2.—Structure of Dora pool on top of Senora limestone. Contour interval, 25 feet. Width of area mapped, 3½ miles.

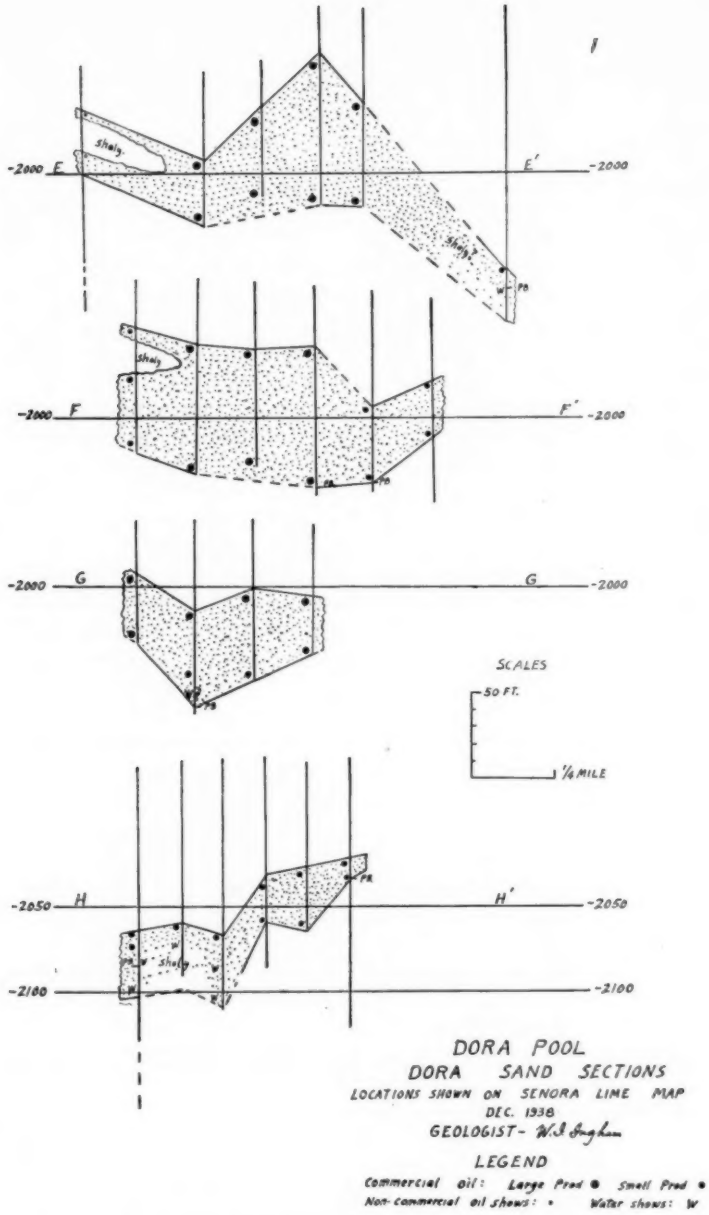


FIG. 3.—Dora sand sections. Locations shown on Senora limestone map. Depths shown in feet. Location of cross section *AA'* (Fig. 4).

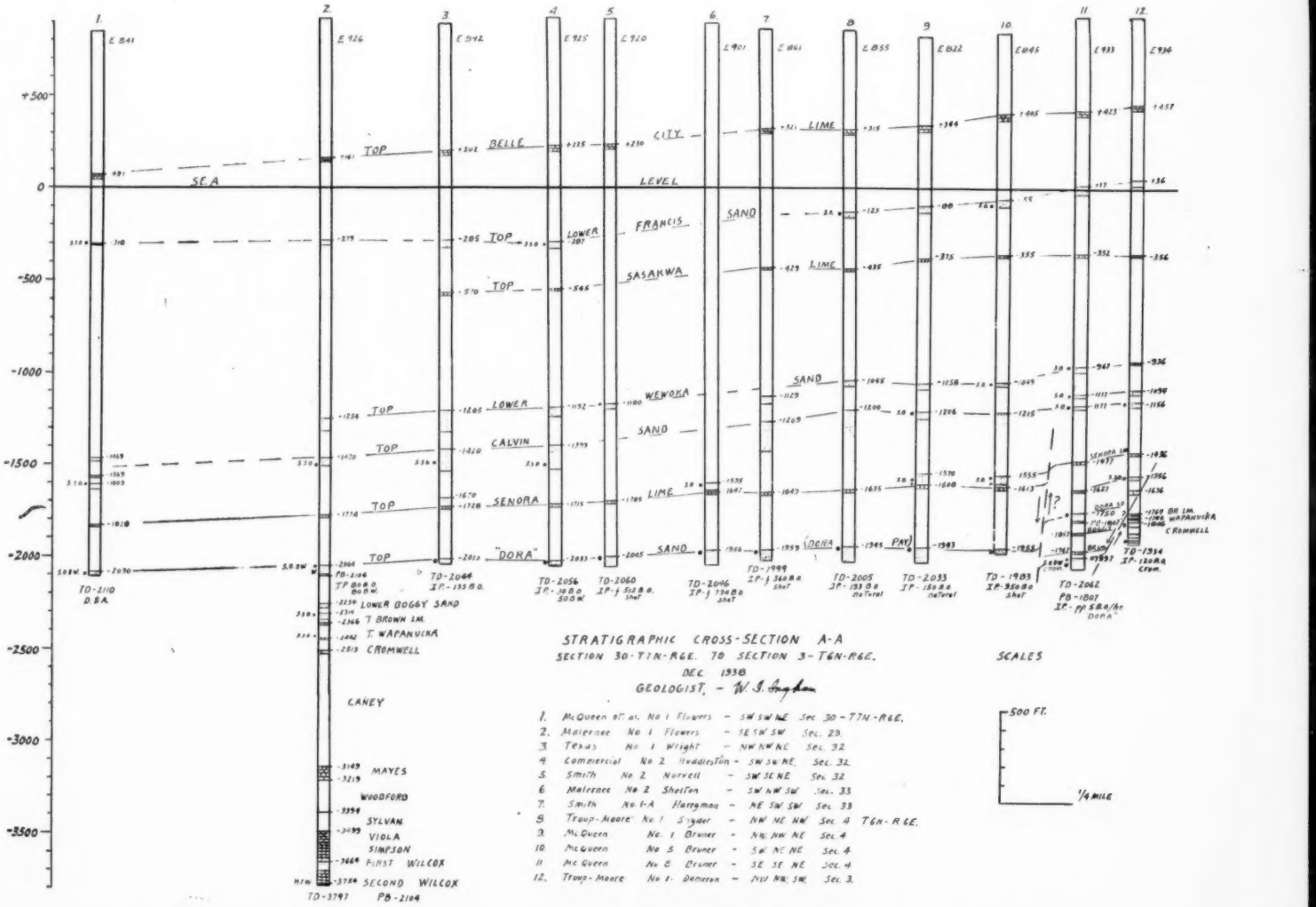


FIG. 4.—Stratigraphic cross section *AA'* (location shown in Figure 3).

Inasmuch as most of the formations are described in previous articles, only the Senora limestone and the "Dora" sand are described in this paper, the former being the datum used for contouring subsurface structure, the latter the pay sand in the pool.

The Senora limestone is 10–20 feet thick and is light tan to gray, medium-hard crystalline limestone. The cuttings show rather flaky and brittle characteristics and are easily identified. This bed is probably the best subsurface marker in the field, and the most reliable for contouring Pennsylvanian structure.

The producing sand is a local lenticular sand member of the Thurman formation to which the name "Dora" has been applied in the subsurface. It is found in this pool from 280 to 330 feet below the Senora limestone, depending on its position on structure. The top of the Thurman formation in the subsurface is placed at the top of the first sand stringer (1–5 feet thick), which occurs in some of the wells 2–15 feet above the main sand body, herein called the "Dora" sand. The Dora sand is medium-grained, brownish gray, subangular, micaceous, slightly glauconitic sand. The sandy shale part of it is dark gray and micaceous. The sand body has a maximum thickness of about 100 feet, but thins out at the edges and locally thins in the interior of the pool. It varies considerably in porosity and in the amount of interbedded shale and sandy shale from well to well. Since practically all of the wells were completed in this sand, no lower formations are discussed in this paper. Other formations that have had oil showings or produced oil in the field are shown by symbols on the composite section and on the cross section.

The Dora pool as mapped in the subsurface is anticlinal. The contour map and sand sections show a nosing or flattening of the structure toward the northwest. There is also a series of small closed domes on a low sinuous anticline, which trends roughly east of north across the north part of Section 4, across Section 33 and the corners of Sections 27, 28, and 34. The enlarged cross sections of the producing Dora sand (Fig. 3) show the shape of the sand deposit. The sand body is more or less convex upward and thins out at the edges. The structure of the pool is apparently that of a sand lens which was deposited across this area during alternate advances and withdrawals of the seas of that time. This was followed by differential settling of the upper formations over the sand body. Later slight local arching resulted in the formation of the noses and domes shown on the structure map.

The pool appears to be faulted and truncated on the extreme southeast end. This is shown on the map and cross section. The cross

section (Fig. 4) shows the relative position of formations in the extreme southeast wells, where faulting is known. The downthrown side of these faults is on the northwest. The fault zone strikes about N. 30° E. This faulting probably occurred during early Pennsylvanian time when great downwarping took place forming the McAlester basin on the southeast. As a result of this movement rocks were faulted in many places. These faults are normal and in general trend 5°–30° E.

From a study of the well logs there appears to be some thickening and thinning in the pre-Boggy formations, particularly in the early Pennsylvanian beds. Erosional and structural unconformities occur within these early formations, as well as in the pre-Mississippian section.

The cross section (Fig. 3) shows a variation in interval between the top of the Senora limestone and top of the Dora sand in the pool. This interval varies from about 280 feet in the northwest end to 330 or 340 feet in the southeast end of the pool. However, in the two extreme southeast wells, which are on the upthrown side of step faults, the interval is shortened to 280 and 200 feet, respectively.

The source of the oil was probably in the Stuart shale immediately above the Dora sand or in the Boggy shales below, or both. It is believed the oil accumulated from these adjacent shale beds which are somewhat bituminous and lignitic. The oil was held in the sand by the shale on the margin of the sand body and accumulated updip toward the southeast against the fault zone.

A total of 87 oil wells and 1 gas well had been completed in the Dora pool to December, 1938. These include 81 oil wells in the Dora sand, one each in the Senora sand, the Calvin sand, and the Cromwell unconformity sand, two in the Francis sand and 1 gas well in the Dora sand. A few edge wells which produced a small amount of oil have been abandoned. These are shown on the structure map (Fig. 2).

The Cromwell sand was penetrated in several edge wells of the pool. All of these tested salt water, except a recent well at the southeast end of the pool, Troup and Moore's Dameron No. 1, in the NW. ¼, NW. ¼, SW. ¼ of Sec. 3, T. 6 N., R. 6 E. This well was completed the latter part of November, 1938, with an initial production of 120 barrels of oil per day from the Cromwell sand 2,742 feet deep. It was later deepened to a lower productive Cromwell sand between 2,845 and 2,860 feet. There is a good possibility of extended "Cromwell unconformity" sand production southeast of this well, where there is a local uplift. The Dora and Boggy sands are thin and shaly here and contained only very light oil showings.

The pool, as far as Dora sand production is concerned, is well

defined on all sides by dry holes or very small producers. No extension of the Dora sand production is believed probable at the northwest end of the pool, where it is limited by the water table found at approximately −2,040 to −2,060 feet. The Dora sand production is further limited by lateral gradation of sand to shale in the other directions.

All wells in this pool are drilled with rotary tools. The average drilling time from under the surface casing ranges from 6 to 10 days. This includes coring and setting casing. Casing is commonly set and cemented on top of the producing sand, and the wells are drilled in with cable tools. The wells are shot with 10–200 quarts of nitroglycerin.

The wells completed in the Dora pool showed initial productions or potentials varying from 8 to 2,850 barrels of oil per day, with an average of 335 barrels per day, per well. Twelve of the edge wells produced water with the oil. Approximately 2,127,200 barrels of oil had been produced from the pool to December, 1938. At that time 41 wells were flowing and 39 were pumping.

There are 860 acres of Dora sand production in the present pool. It is estimated that 41,320 acre feet of Dora oil sand are present in the pool. There is an average sand thickness of 49 feet. It is calculated that the pool will eventually produce 9,362,200 barrels of oil from the Dora sand, a per acre yield of 9,830 barrels.

UNCONFORMITY AT BASE OF WHITEHORSE FORMATION, OKLAHOMA

CORRECTION

In the published article, "Unconformity at Base of Whitehorse Formation, Oklahoma," this *Bulletin*, December, 1937, the writer correlated the dolomite bed at the base of the Blaine formation, and the top of the Chickasha-Duncan formation, in the Pocasset, Oklahoma area, with the fossiliferous dolomite bed exposed south and west of El Reno, Oklahoma. Several competent geologists have followed this bed from the north of El Reno, and place it near the top of the Blaine formation rather than its base. The writer believes the correlation which he made to be in error, and take this means to correct it.

OTTO E. BROWN

VINCENNES, INDIANA
April, 1939

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 23, NO. 5 (MAY, 1939), PP. 699-704

DISCUSSION

GEOLOGY OF CENTRAL VENEZUELA[1]

L. KEHRER[2]
Maracaibo, Venezuela

INTRODUCTION

In the *Bulletin* of the American Association of Petroleum Geologists, Vol. 22, No. 9 (September 1938, pp. 1224–30), appeared a paper by M. Kamen Kaye, "Geological Succession of Central Venezuela."

The writer had the opportunity of studying sections in central Venezuela as geologist for the "Shell" groups working in Venezuela, and, although he is in agreement in some respects with the paper mentioned, he hopes that it does not seem out of place to submit a few additional data and to offer some discussion and criticism. He wishes to thank the Venezuelan Oil Development Company, Ltd., who have kindly given their permission for the publication of this paper.

GENERAL CONSIDERATIONS

It appears that Kaye considers the Venezuelan Andes and the Coast Range as a geanticline and the Llanos area as a geosyncline, bordered in the south by the Brazilian shield (Guayana massive). This may be correct if only a post-Eocene syncline is considered; however, it does not seem to hold good for the Mesozoic and Paleozoic geosynclines, which were doubtless north of the Llanos, that is, in the zones of the major folding. A great part of the present Venezuelan Llanos seems not to lie in a true geosynclinal zone but rather on the northern shelf of the Guayana massive. The terms geosyncline and geanticline should always be used with the necessary limitations and given their proper meaning.

COAST RANGE COMPLEX

In contradiction to Kaye it appears that tectonically the Venezuelan Andes and the Coast Range do not contrast so sharply, as both ranges show thrust movement toward the north and also toward the south. In sections between La Guaira-Maiquetia and Catia de la Mar, the younger Tertiary of Cabo Blanco, the age of which has been determined as Middle Miocene based on mollusks and foraminifera, is noticed as dipping 10°–55° toward the Caribbean mountains (at Cabo Blanco and in Quebrada Tacagua) and the metamorphic rocks at and near the contact show overturned or vertical dips and are badly crushed and broken. This is a feature common in many places at the edge of the Andes where also Kaye admits upthrusts, and also along the southern and northern rims of the Venezuelan Andes zones exist where the thrusts go over in steep faults or where the tectonic contact is obscured by overlapping younger Tertiary beds.

It may be added that in San Juan de los Morros-Ortiz-Calabozo section,

[1] Manuscript received, March 8, 1939.

[2] The Caribbean Petroleum Company, Ltd.

to which apparently most of the data in Kaye's paper apply, shows almost exclusively south dips north of San Juan toward Villa de Cura, that is, thrust movement toward the north. However, it is true that from San Juan toward the south northerly dips prevail, indicating thrusts toward the south.

As to the age of the metamorphosed sediments of the Coast Range, the writer has discussed this matter already[3] and agrees that careful sampling and examination of slides may give a definite solution of this problem.

It is the writer's belief that the granitic cores of the Coast Range are intruded in the sedimentary rocks and that therefore the metamorphism is not solely due to tectonic movements. Probably due to superficial intrusion and low temperature of the granitic magma, contact phenomena are not as prominent as mentioned in many textbooks on geology. There is no doubt that the Coast Range is tectonically much disturbed and greatly broken and that the late orogenic movements have obscured much of the once existing intrusive tectonics. This may be one of the reasons, besides many others, accounting for the fact that it seems not possible to determine properly the age of the intrusions in the Coast Range and in many parts of the Venezuelan Andes.

FOOTHILL ZONE OF COAST RANGE

According to Kaye's description, this zone comprises the area south of a line extending approximately from Boca de Uchire-San Sebastian-San Juan de los Morros-Tinaco to San Carlos, that is, the southern flank of the Venezuelan Interior Range (Serrania del Interior). This Interior Range continues eastward in the mountain system of Barcelona-Cumanacoa and the Central Range of Trinidad. In this are exposed chiefly Cretaceous-Eocene strata, not at all or only locally metamorphosed on account of smaller or larger imbrications, thrusts, and faults.

In principle, the Cretaceous can be divided into a lower part predominantly sandstones (Tomon sandstones, Uribante sandstones, Barranquin sandstones), a middle group of limestone, slates, and cherty slates (Luna-Cogollo limestone, Cantil-Guayuta formation, Bergantin-Querecual beds) and an upper division of shales, marls, and a few sandy and calcareous intercalations (Colon shales, Guayuta group, San Antonio formation).

The lowest member with *Weichselia mantelli*[4] in the east and *Astieria* and *Exogyra couloni* in the western Venezuelan Andes places this group in the Valanginian-Hauterivian (Lower Cretaceous), and *Sphenodiscus lenticularis*[5] from the Colon shales in the west indicates Campanian (Upper Cretaceous).

Kaye states that the basal Cretaceous sandstone grades out laterally toward the west. However, it can still be observed within central Venezuela in the Morro de Unare and in the thrust zone north of San Francisco de Tisnados. We know that this group undergoes lateral changes of facies. In the Andean region it contains a considerable amount of shales and sandy shales, and pure sandstones are rather subordinated, for example, La Cuchilla on

[3] L. Kehrer, "Some Observations on Cretaceous and Pre-Cretaceous Beds in the Southwestern and Northern Central Parts of Venezuela," *Bol. de Geologia y Mineria, Ministero de Fomento*, Vol. 1, pp. 47–70. Caracas, 1937. English edition.

[4] O. Schlagintweit, "Weichselia Mantelli im Nordöstlichen Venezuela," *Centralbl. für Min., etc.* (1914), pp. 315–19.

[5] L. Kehrer, *op. cit.*, p. 51.

car-road between Carora and Trujillo. In the Cuchilla, in the Guanta-Cumaná, Valera, and western Andes regions, intercalations of fossil-bearing limestones are numerous.

Orbitolina (*texana*?) abounds in some of these Lower Cretaceous limestones, at various localities accompanied by *Choffatella*.

The Eocene of central Venezuela consists of alternating flaggy sandstones, tuffaceous sandstones, fossiliferous reef limestones, conglomeratic beds, shales, and marls. In central Venezuela it is very distinctly of the Eocene Misoa-Trujillo facies type of the southeastern Maracaibo Lake basin. It is quite clear that any geologists working in such a region, already showing stratigraphically many repetitions of individual beds in a zone of many thrusts, imbrications, and faults, will find great difficulties in distinguishing the beds properly.

As already pointed out by the writer at an earlier date[6] the field evidence points rather to a transition from Cretaceous to Eocene than to a sharp break of sedimentation. The writer is therefore not surprised that Kaye found Upper Cretaceous foraminifera not far from post-quartzitic beds, which latter he considers apparently as Eocene.

The Ortiz sandstone of Liddle[7] is exposed 3 or 4 kilometers south of the village of Ortiz. It has been given an Eocene age, based on fossils found near Boca Unare about 240 kilometers east of Liddle's type locality. Unfortunately Liddle gives no exact description of the Unare locality and its fossil content. He compares it with the Eocene Misoa-Trujillo formation of the Maracaibo Lake basin, or the Mirador sandstone of the westernmost Venezuelan Andes. It builds up the so-called "Galeras," a range of prominent hills forming the northern edge of the Venezuelan Llanos between San Carlos in the west and Boca Unare in the east. According to Liddle the Ortiz sandstone is underlain by shales, "though barren of fossils in this region [Ortiz] yield Upper Cretaceous fossils to the west and east." It rather seems that Liddle has taken the age of the underlying beds as a base for his conclusion that the overlying beds, namely, his Ortiz sandstone, are Eocene. However, the writer can not attach much value for age determination of the Ortiz sandstone to Liddle's argument, especially as it is known that the thrusting and faulting is common in the Ortiz area and that the Cretaceous Colon shales and the Eocene lower Misoa-Trujillo formation have a striking lithologic similarity. During his field work, in 1934, in the Ortiz area the writer doubted the Eocene age of the Ortiz (the Galera sandstone) and expressed his opinion as to the probable Miocene age of the Ortiz sandstone during the excursions in this area on the occasion of the first Venezuelan Geological Congress in February, 1937. The writer's arguments were then the following. "Were the Ortiz sandstones really Eocene such a sandstone body, reaching a thickness of about 800 m., should also be found somewhere in the thrusted and imbricated zone farther north." Owing to the absence of the Ortiz sandstone north of the type locality it was concluded that it could represent probably post-Eocene strata. The lithologic appearance of the sandstone was very similar to the Lower Miocene Cerro Pelado series of Falcon. Furthermore, fossils described by

[6] L. Kehrer, *op. cit.*, pp. 50–51.

[7] R. A. Liddle, *The Geology of Venezuela and Trinidad*, pp. 208–16. Fort Worth (1928).

Karsten[8] from the Galera de Pao area seemed rather of Miocene than of Eocene age.

Since last year new data have been collected, and according to Dallmus[9] it appears that the Galera (Ortiz) sandstone corresponds with Mio-Oligocene. Hedberg, in a personal note to the writer, has come to similar conclusions, that is, post-Eocene age, working from his Querecual section[10] westward. It appears, therefore, that a post-Eocene age for the Ortiz sandstone is admitted.

The sharp break mentioned by Kaye, between the flaggy quartzitic horizons and the more massive Ortiz (Galera) sandstone seems an unconformity of Lower Miocene on Eocene, very similar to the Los Algodones unconformity of northern Lara.[11] The orbitoidal limestones mentioned by Kaye, in the lower part of the Eocene section are similar to those in the Mene Grande area, described by Tash.[12] They form along the southern foothill zone of the Coast Range (Interior Range) a well defined level to be followed east of Tinaco to the Clarines area in the state of Anzoategui. Owing to its reef character it does not form a solid continuous horizon, but can be recognized at numerous localities along this zone.

POST-ORTIZ ZONES

As discussed before, we consider the Ortiz (Galera) sandstone as Lower Miocene, similar to the Cerro Pelado sandstone of Falcon and can agree that the beds south of the Galeras represent Middle to Upper Miocene horizons. The calcareous facies of some of these younger Tertiary beds resemble beds of similar age in the state of Falcon. These were for the greater part still included in the late orogenic movements. It is, of course, a question by itself whether the deeper strata, that is, Eocene-Cretaceous, still reflect these surface structures or whether these younger beds are sheared off from an Eocene-Cretaceous "basement," Most probably geophysical investigations have given, and are to give, in individual cases, the solution to this problem.

The tilted terraces and mesas seem to prove that in very recent time tectonic forces were still active, a fact which is also evidenced by frequent earthquakes which have repeatedly destroyed many towns and villages in Venezuela in the last few centuries. The writer prefers to attribute these recent movements to adjustments in the still active, folding zone, that is, Andes and Coast Range, than to the rigid and more stable Guayana shield and shelf. As an example, the writer remembers the south-sloping terrace, overlying younger Tertiary beds in the region south of Pariaguan, from San Diego de Cabrutica toward the Orinoco River. It has to be admitted, however, that this is not positively clear evidence as the effect, i.e., south sloping

[8] H. Karsten, *Géologie de l'ancienne Colombie Bolivarienne, Venezuela, Nouvelle—Grenade et Ecuador*. Friedlander & Sohn, Berlin (1886).

[9] K. F. Dallmus, "Geology of El Valle de Guanape Area, District of Bruzual, Anzoategui," read at the second Venezuelan Congress, San Cristobal, April, 1938, and discussions on this paper.

[10] H. D. Hedberg, "Stratigraphy of the Rio Querecual Section of Northeastern Venezuela," *Bull. Geol. Soc. America*, Vol. 48 (1937).

[11] L. Kehrer, *op. cit.*, p. 50.

[12] G. E. Tash, "Stratigraphy and Paleontology of Mene Grande and Vicinity," *Bol. de Geologia y Mineria, Ministerio de Fomento*, Vol. 1, pp. 159–172. Caracas, 1937. English edition.

of the terraces, could be caused either by uplift of the Coastal Range zone or the sinking of the Guayana shield.

As to the origin of the milky white quartz pebble beds, the writer is more inclined to look for their origin in the Guayana area than in the Caribbean Coast Range. Although quartz veins are locally abundant in the metamorphic rocks of the Coast Range, they would hardly account for the large amount of quartz pebbles in the southern part of the Venezuelan Llanos.

Therefore, it seems more logical to look for a near-by source, which would be from the river system south of the Orinoco, especially when we consider the drainage system of the Coast Range, flowing in two directions, that is, north into the Caribbean Sea and south into the Orinoco River, being rather short and insignificant compared with the system south of the Orinoco. Probably the Orinoco River originally flowed farther north and on account of tectonic movements, either uplift of the Caribbean mountains or sinking of the Guayana shield, it has moved gradually to its present course farther south. The writer would not be at all surprised if somebody would prove that the Orinoco emptied at a certain period via the Unare-Barcelona depression into the Caribbean Sea. Such a possibility would explain the presence of milky white quartz pebbles in large areas in the states of Guarico and Anzoategui.

M. KAMEN KAYE, Caracas, Venezuela (manuscript received, April 24, 1939). I could have wished for no better consequence of my paper published in the *Bulletin* of September, 1938, than a continuation and enlargement of the subject by Dr. Luis Kehrer. Dr. Kehrer is not only one of the most experienced field geologists in Venezuela but also has for reference many of the splendid data which the company he represents has accumulated in Venezuela.

With regard to the boundaries or limits of the Venezuelan geosyncline, I indicated that its various sectors lay between the Orinoco and the schistose masses of the north. Within these limits lie the sedimentaries of the foothills as well as the llanos themselves. The strata involved, therefore, range from Lower Cretaceous to Quaternary. With regard to older geosynclines, I indicated their geography in the statement part of which reads. . . . "the schistose mass of Venezuela was once sediment in Palaeozoic seas; further, that the southern shores of these seas may not have been distant from the present Venezuelan coastline."

With reference to the "post-quartzitics" I regret that my statement concerning them is probably not clear on a casual reading. The "post-quartzitics" actually refer to the Ortiz formation so named by Liddle, my use of the phrase being a matter of lithological distinction. I, as well as Dr. Kehrer, discuss this formation at some length. Since my own paper was in part a review of problems in the geological succession, I gave prominence to other opinions as well as my own. My own opinion with regard to the Ortiz formation appears as a discussion together with sketches which I subscribed to the Second Venezuelan Congress (San Cristobal, 1938) following a paper by K. F. Dallmuss on the geology of the Valle de Guanape area. Both the paper by Dallmuss and my sketches appear in the *Boletin de Geologia y Mineria*, Nos. 2-3-4, published by the Venezuelan Government. The sketches show that I consider part of the Ortiz formation as post-Eocene. It may well be that Dr. Kehrer is correct in placing even the basal part of the Ortiz, that is, the Galera sandstone, also in post-Eocene. On the other hand, I would like more heavy-mineral evidence from the Galera sandstones to be sure on this point. I would

also like to recommend some caution in placing the Galera sandstones as Lower Miocene. It is always difficult to show that a given column of Caribbean Tertiaries lies in the Oligocene, but we must remember that a place exists to be filled between the Eocene and the Miocene which unconformity might not wholly explain.

I am little familiar with the schist-limestone-intrusive igneous section north of San Juan on the way to Villa de Cura but I am not sure that south dips in that vicinity presuppose thrusting toward the north. Dr. Kehrer is probably aware of south dips within the schists themselves where the hard quartzitic members are exposed in the heart of the coastal movements, for example, around Los Teques; yet I doubt that he would explain such south dips by thrusting toward the north. It may be a question of rock competency which sometimes preserves a limb of anticline or syncline where in other conditions it would be overturned. A general synclinal structure is not an impossible explanation for the re-appearance of the reef limestones near Villa de Cura.

The Middle Miocene age accepted by Dr. Kehrer for the sediments at Cabo Blanco on the sea-shore north of Caracas does not find favor with me. Foraminiferal evidence is frequently misleading in isolated areas far from centers of detailed knowledge. Also, I would suggest that the gigantism of the molluscs at Cabo Blanco in itself suggests the possibility that we are dealing in this case with post-Miocene deposition. For similar reasons, I would dispute Maury's Middle Miocene age determinations on the coast near Cumana. Some of the very young sediments in the Venezuelan column develop a surprising hardness through secondary chemical reactions and this secondary consolidation when seen in samples may bias the ultimate findings. As for the dips displayed in the Cabo Blanco sediments, their inclination toward the schists may not only be local but also late and very short-lived movements. Their presence therefore need not necessarily discount the orogenic distinction I was trying to make between the Andean and the Coast Range.

Dr. Kehrer's derivation of the mesa quartz pebbles by north transport of an augmented Orinoco system of rivers is feasible and should receive attention from geologists working in Venezuela mesa areas. Presumably, the first result of north transport would be a natural depositional dip toward the north. This would later have to be reversed by mechanical tilt toward the south. Since we are dealing here with practically the top of the central Venezuela column, we would have to suppose that the pre-mesa beds underwent a similar mechanical tilt toward the south in post-mesa time. Actually, geophysical investigations in practically all parts of Venezuela well away from the foothills show that southern components of dip are rare in the pre-mesa beds. It may be that the mechanical post-mesa tilt toward the south was sufficient only to reduce the dip component of the north-dipping pre-mesa beds without being able to reverse the component. In such a case, Dr. Kehrer's theory would hold good ground.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 23, NO. 5 (MAY, 1939), PP. 705-706

REVIEWS AND NEW PUBLICATIONS

* Subjects indicated by an asterisk are in the Association library and available to members and associates.

RECENT PUBLICATIONS

GENERAL

*"An Advance in Exploration by Soil Analysis Methods," by Malvin G. Hoffman. *Oil and Gas Jour.*, Vol. 37, No. 44 (Tulsa, March 16, 1939), pp. 23–24, 115.

Six-Volume Index, Vols. 31–36. Amer. Jour. Sci., New Haven, Connecticut (1939). Price $1.25.

*"Pennsylvanian Correlations in the Eastern Interior and Appalachian Coal Fields," by Harold R. Wanless. *Geol. Soc. America Spec. Paper 17* (New York, March 20, 1939). 130 pp., 9 pls., 8 figs., 7 tables.

*"Wildcat Drilling in 1938," by Frederic H. Lahee. *Oil and Gas Jour.*, Vol. 37, No. 45 (Tulsa, March 23, 1939), pp. 46, 146; 1 fig.

Elements of Geology, with Reference to North America, by William J. Miller. 2d ed. (1939). 524 pp., including index of 18 pp., 367 figs. 6×9 inches. Cloth. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York. Price, $3.50.

Geology and Allied Sciences, by Walther Huebner. A thesaurus and a coordination of English and German specific and general terms. Part I, German-English. In press. Approx. 400 pp. 5.625×8.375 inches. Veritas Press, Inc., 250 West 57th Street, New York. Price, $7.50. (The English-German part is expected to be published in October, 1939.)

ILLINOIS

"Isopach Map of the Chester Series below the Pennsylvanian System." *Illinois Geol. Survey* (March, 1939). Scale: 1 inch = 8 miles. Contour interval, 100 feet. Blue-line print. Order from map agent, 305 Ceramics Building, Urbana. Price, $0.45.

"Structure of Herrin (No. 6) Coal Bed in Hamilton, White, Saline, and Gallatin Counties, Illinois, North of Shawneetown Fault," by G. H. Cady, with "Notes on Oil and Gas Possibilities," by Alfred H. Bell. *Illinois Geol. Survey Cir. 42* (Urbana, May, 1939). Gratis.

"Structure Map of No. 6 Coal," to accompany Cir. 42. Blue-line print, 45×45 inches. Scale, 1 inch = 1 mile. Price, $0.75.

"Base Map, Showing Drill Holes and Mines," *ibid.* Price, $0.75.

"Tabulated Data," to accompany Cir. 42. Data on mines and drilling. Price, $1.50.

INDIA

*"The Himalayan Border Compared with the Alps," by Arnold Heim. *Records Geol. Survey of India*, Vol. 72, Pt. 4 (Calcutta, 1938), pp. 413–21; 3 figs.

**Geographical Index to the Memoirs, Volumes I-LIV [and] Records, Volumes I-LXV of the Geological Survey of India and General Reports of the Di-*

rector for the Years 1897 to 1903, by T. H. D. La Touche. 576 pp. 7×10.25 inches. Paper cover. Geological Survey of India, 27 Chowringhee Road, Calcutta. Price, 11s.

MICHIGAN

*"The Geology of Allegan County," by C. H. Riggs. *Michigan Geol. Survey Prog. Rept. 4* (Lansing, December, 1938). 29 mim. pp., 13 maps and sections in pocket. Paper. 8.375×10.75 inches. Price, $0.75.

RUSSIA

*"A Visit to Russian Oil Districts," by H. G. Kugler. *Jour. Inst. Petroleum*, Vol. 25, No. 184 (London, February, 1939), pp. 68–88; 4 photographs, 7 maps and geologic sections.

TEXAS

*"Lower Canyon Production in West-Central Texas," by H. H. Adams, Carl Shoults, and T. C. Thompson. *Oil and Gas Jour.*, Vol. 37, No. 45 (Tulsa, March 23, 1939), pp. 32–33, 41; 3 figs.

UGANDA

*"A Series of Papers Relating to the Geology of Uganda with Bibliography and Provisional Map." *Geol. Survey Uganda Bull. 3* (1939). 196 pp., 8 pls. of photographs, 23 figs., 3 tables, 3 maps. Approx. 8×10.25 inches outside dimensions. Cloth. Geological Survey Office, Box 9, Entebbe, Uganda. Price, 10s. 6d.

ASSOCIATION DIVISION OF PALEONTOLOGY AND MINERALOGY

**Journal of Paleontology* (Tulsa, Oklahoma), Vol. 13, No. 2 (March, 1939).

"An Ammonoid Fauna from the Lower Pennsylvanian Cherokee Formation of Missouri," by A. K. Miller and John Britts Owen

"Ostracodes from the Maquoketa Shale of Iowa," by R. C. Spivey

"Claiborne Eocene Species of the Ostracode Genus *Cytheropteron*," by James L. Martin

"Large Foraminifera from Guam," by W. Storrs Cole

"Devonian and Silurian Foraminifera from Oklahoma," by Hubert A. Ireland

"Mississippian Formations in Southern Illinois," by H. N. Coryell

"Unusual Occurrence of *Isotelus gigas* DeKay in the Bromide Formation of Southern Oklahoma," by L. R. Laudon

"Ostracoda of the Clore Limestone," by H. N. Coryell and Samuel C. Johnson

"A Simple Apparatus for Sorting Microfossils," by Adolf Franke

"Platycrinid Columnals in Lower Permian Limestone of Western Texas," by Raymond C. Moore

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 23, NO. 5 (MAY, 1939), PP. 707-756

THE ASSOCIATION ROUND TABLE

MEMBERSHIP APPLICATIONS APPROVED FOR PUBLICATION

The executive committee has approved for publication the names of the following candidates for membership in the Association. This does not constitute an election but places the names before the membership at large. If any member has information bearing on the qualifications of these nominees, he should send it promptly to the Executive Committee, Box 979, Tulsa, Oklahoma. (Names of sponsors are placed beneath the name of each nominee.)

FOR ACTIVE MEMBERSHIP

Stanley W. Blanchard, Wichita, Kan.
Edward A. Koester, Donald M. Allen, R. A. Whortan
Douglas Bundy, Santa Monica, Calif.
Joseph Jensen, H. J. Steiny, Ashly S. Holston
James Gilluly, Los Angeles, Calif.
W. T. Nightingale, U. S. Grant, R. D. Reed
Richard Henry Schweers, Fort Worth, Tex.
Herbert H. Bradfield, Joseph H. Markley, Jr., R. S. Powell

FOR ASSOCIATE MEMBERSHIP

John Edward Backman, Pittsburgh, Pa.
E. A. Eckhardt, R. W. Clark, J. C. Heggblom
Russell Warren Burns, Los Angeles, Calif.
E. F. Schramm, E. B. Noble, Max L. Krueger
John Duncan Henderson, El Dorado, Ark.
W. F. Bowser, W. B. Weeks, E. D. Klinger
Robert Grant Hill, Golden, Colo.
W. A. Waldschmidt, F. M. Van Tuyl, C. A. Heiland
Dale David Kerstetter, Golden, Colo.
W. A. Waldschmidt, Dart Wantland, F. M. Van Tuyl
Francis Edgar Lozo, Jr., Princeton, N. J.
Gayle Scott, W. T. Thom, Jr., B. E. Thompson
Milton Frank Reedy, Jr., Dallas, Tex.
E. H. Sellards, Hal P. Bybee, J. C. Karcher

FOR TRANSFER TO ACTIVE MEMBERSHIP

Oscar R. Champion, Midland, Tex.
W. D. Anderson, James R. Day, Charles D. Vertrees
J. P. Davidson, Alice, Tex.
R. A. Birk, Robert M. Franks, Richard T. Short
Hugh Cecil Schaeffer, Pasadena, Calif.
H. L. Griley, A. F. Truex, Frank C. Greene
William Ward West, Midland, Tex.
Dana M. Secor, Russell C. Conkling, Cary P. Butcher

ASSOCIATION COMMITTEES

EXECUTIVE COMMITTEE

HENRY A. LEY, *chairman*, Southern Cross Oil Company, San Antonio, Texas
ED. W. OWEN, *secretary*, L. H. Wentz (Oil Division), San Antonio, Texas
DONALD C. BARTON, Humble Oil and Refining Company, Houston, Texas
L. MURRAY NEUMANN, Carter Oil Company, Tulsa, Oklahoma
W. A. VER WIEBE, University of Wichita, Wichita, Kansas

REPRESENTATIVE ON DIVISION OF GEOLOGY AND GEOGRAPHY NATIONAL RESEARCH COUNCIL

FREDERIC H. LAHEE (1940)

FINANCE COMMITTEE

E. DEGOLYER (1940) WALLACE E. PRATT (1941) W. B. HEROY (1942)

TRUSTEES OF REVOLVING PUBLICATION FUND

RALPH D. REED (1940) GEORGE S. BUCHANAN (1941) FLOYD E. MILLER (1942)

TRUSTEES OF RESEARCH FUND

SAM M. ARONSON (1940) ARTHUR A. BAKER (1941) WALTER R. BERGER (1942)

BUSINESS COMMITTEE

C. C. ANDERSON (1940)
H. K. ARMSTRONG (1941)
A. A. BAKER (1940)
W. A. BAKER (1939)
D. C. BARTON (1940)
E. J. BARTOSH (1940)
N. WOOD BASS (1941)
A. H. BELL (1941)
J. BOYD BEST (1941)
L. D. CARTWRIGHT (1941)
J. I. DANIELS (1941)
R. K. DEFORD (1941)
C. E. DOBBIN (1941)
H. L. DRIVER (1941)
H. M. HUNTER (1941)
G. M. KNEBEL (1941)
HENRY A. LEY (1941)
P. W. MCFARLAND (1940)
C. C. MILLER (1941)
C. L. MOODY (1941)
L. M. NEUMANN (1940)
H. H. NOWLAN (1941)
ED. W. OWEN (1940)
VIRGIL PETTIGREW (1940)
PAUL H. PRICE (1941)
GAYLE SCOTT (1940)
H. B. STENZEL (1940)
W. T. THOM, JR. (1941)
W. C. THOMPSON (1940)
C. W. TOMLINSON (1941)
W. A. VER WIEBE (1940)
E. B. WILSON (1941)
W. B. WILSON (1940)
ROBERT H. WOOD (1941)
C. E. YAGER (1941)

ASSOCIATION COMMITTEES

COMMITTEE FOR PUBLICATION

R. E. RETTGER (1942), *chairman*, Sun Oil Company, Dallas, Texas

1940	1941	1942
CARL C. ADDISON	ROBERT F. IMBT	CHARLES G. CARLSON
GEORGE R. DOWNS	T. C. CRAIG	W. W. CLAWSON
HAROLD W. HOOTS	THOMAS H. ALLAN	JAMES TERRY DUCE
J. HARLAN JOHNSON	PHIL F. MARTYN	C. E. DOBBIN
A. M. LLOYD	J. T. RICHARDS	COLEMAN D. HUNTER
JOSEPH J. MAUCINI	J. MARVIN WELLER	R. E. RETTGER
GRAHAM B. MOODY		FRED H. WILCOX

RESEARCH COMMITTEE

A. I. LEVORSEN (1942), *chairman*, 221 Woodward Boulevard, Tulsa, Oklahoma

1940	1941	1942
G. MOSES KNEBEL	E. WAYNE GALLIHER	N. WOOD BASS
EUGENE MCDERMOTT	D. PERRY OLCOTT	MONROE G. CHENEY
GAYLE SCOTT	BEN H. PARKER	RONALD K. DEFORD
	WENDELL P. RAND	BELA HUBBARD

GEOLOGIC NAMES AND CORRELATIONS COMMITTEE

JOHN G. BARTRAM (1942), *chairman*, Stanolind Oil and Gas Company, Tulsa, Oklahoma

1940	1941	1942
PHILIP K. COCHRAN	MONROE G. CHENEY	JOHN E. ADAMS
GLENN S. DILLE	ROBERT H. DOTT	GENTRY KIDD
BENJAMIN F. HAKE	HAROLD N. HICKEY	HUGH D. MISER
R. M. KLEINPELL	MERLE C. ISRAELSKY	RAYMOND C. MOORE
C. W. TOMLINSON	WALTER K. LINK	

PERMIAN SUB-COMMITTEE

C. W. TOMLINSON (1940), *chairman*, 509 Simpson Building, Ardmore, Oklahoma

1941	1942
MONROE G. CHENEY	JOHN E. ADAMS
ROBERT H. DOTT	RAYMOND C. MOORE

REPRESENTATIVES TO SIXTH PACIFIC SCIENCE CONGRESS PACIFIC SCIENCE ASSOCIATION

ROY M. BARNES, Continental Oil Company, Los Angeles, California
HAROLD W. HOOTS, Richfield Oil Corporation, Los Angeles, California
MAX L. KREUGER, Union Oil Company, Los Angeles, California
STANLEY G. WISSLER, Union Oil Company, Compton, California

PAST AND PRESENT OFFICERS OF THE ASSOCIATION

In	*Elected At*	*President*	*Vice-President*[1]	*Secretary-Treasurer*[2]	*Editor*[3]
1917	Tulsa	J. Elmer Thomas	Alex. Deussen	M. G. Mehl	C. H. Taylor
1918	Oklahoma City	Alex. Deussen	I. C. White	W. E. Wrather	C. H. Taylor
1919	Dallas	I. C. White[4]	Irving Perrine	C. E. Decker	C. H. Taylor
1920	Dallas	W. E. Pratt	Alex. W. McCoy	C. E. Decker	R. C. Moore
1921	Tulsa	G. C. Matson	G. C. Gester	C. E. Decker	R. C. Moore
1922	Oklahoma City	W. E. Wrather	Max W. Ball	C. E. Decker	R. C. Moore
1923	Shreveport	Max W. Ball	F. W. DeWolf	C. E. Decker	R. C. Moore
1924	Houston	J. H. Gardner	E. G. Gaylord	C. E. Decker	R. C. Moore
1925	Wichita	E. L. DeGolyer	R. S. McFarland	C. E. Decker	R. C. Moore
1926	Dallas	Alex. W. McCoy	C. R. McCollom	Fritz L. Aurin	J. L. Rich
1927	Tulsa	G. C. Gester	Luther H. White	David Donoghue	J. L. Rich
1928	San Francisco	R. S. McFarland	J. E. Elliott	David Donoghue	J. L. Rich
1929	Fort Worth	J. Y. Snyder[5]	Fred H. Kay	A. R. Denison	F. H. Lahee
1930	New Orleans	Sidney Powers[6]	Ralph D. Reed	Marvin Lee	F. H. Lahee
1931	San Antonio	L. P. Garrett	L. C. Decius	Frank R. Clark	F. H. Lahee
1932	Oklahoma City	F. H. Lahee	R. J. Riggs	W. B. Heroy	R. D. Reed
1933	Houston	Frank R. Clark	George Sawtelle	W. B. Heroy	L. C. Snider
1934	Dallas	W. B. Heroy	E. B. Hopkins	M. G. Cheney	L. C. Snider
1935	Wichita	A. I. Levorsen	F. A. Morgan	E. C. Moncrief	L. C. Snider
1936	Tulsa	Ralph D. Reed	C. E. Dobbin	Chas. H. Row	L. C. Snider
1937	Los Angeles	H. B. Fuqua	C. L. Moody	Ira H. Cram	W. A. Ver Wiebe
1938	New Orleans	D. C. Barton	H. W. Hoots	Ira H. Cram	W. A. Ver Wiebe
1939	Oklahoma City	Henry A. Ley	L. M. Neumann	Ed. W. Owen	W. A. Ver Wiebe

[1] From March, 1929, to March, 1932, the corresponding office was *first vice-president*.
[2] From March, 1929, to March, 1932, the corresponding office was *second vice-president in charge of finances*.
[3] From March, 1929, to March, 1932, the corresponding office was *third vice-president in charge of editorial work*.
[4] Died, November 25, 1927.
[5] Died, January 10, 1939.
[6] Died, November 5, 1932.

TWENTY-FOURTH ANNUAL MEETING THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS SKIRVIN TOWER HOTEL, OKLAHOMA CITY, OKLAHOMA MARCH 22–24, 1939

The annual meeting at Oklahoma City was attended by geologists seemingly from all parts of the United States and several distant countries. There were representatives of oil regions scattered from Canada to Argentina, from Europe to the East Indies. The final count was a total of 1,858—more than had attended any previous meeting.

The Skirvin Hotel was designated the convention headquarters and here the officers and several committees held their annual conferences. The usual crowding in the lobby of the headquarters hotel was lessened by holding the main events in the Skirvin Tower Hotel just across the street, connected by a convenient subway. The registration and information counters were located in the lobby of the "Tower," the oil-field, laboratory, and other exhibits were on the mezzanine, and the technical program was in the Silver Glade Room immediately above the exhibits. Stairways and elevators conveniently connected these three floors.

Twenty-five exhibitors filled the mezzanine with educative displays of equipment used in aerial, surface, and subsurface methods of exploration.

The technical program in the Silver Glade Room contained 71 papers, of which 48 were delivered orally and the remainder by title. The program was arranged in six half-day sessions of geologic and geographic groups: (1) general session which was a joint meeting with the Society of Economic Paleontologists and Mineralogists and the Society of Exploration Geophysicists, (2) Permian symposium, (3) Mid-Continent-Pennsylvanian session, (4) economics and recent developments, (5) Mississippi embayment, and (6) Eastern Interior basin.

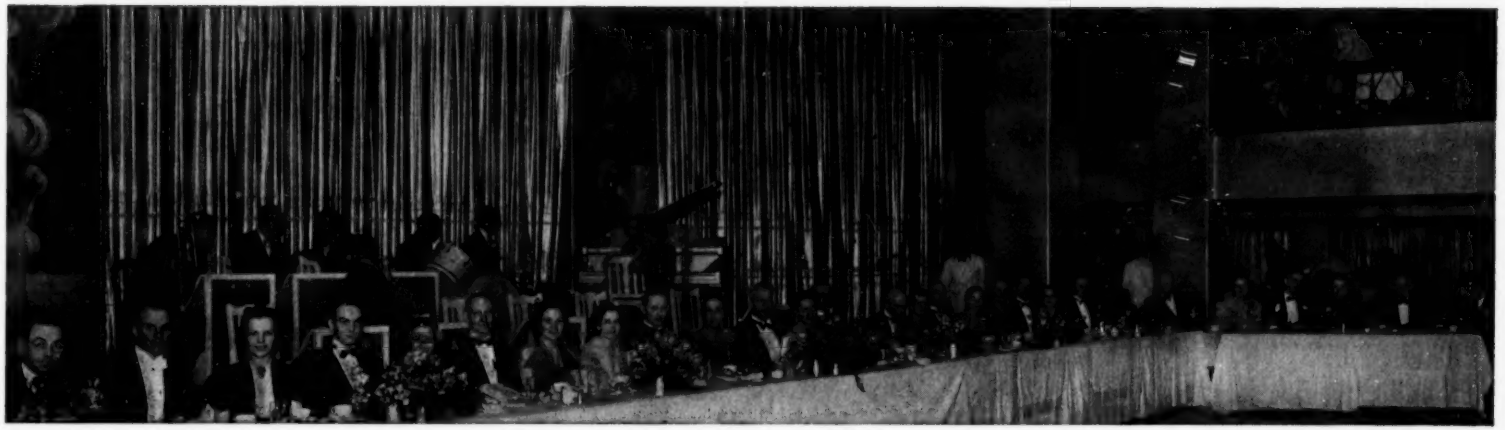
The sessions of the Division of Paleontology and Mineralogy were held in the Crystal Room of the Skirvin Hotel. Fourteen papers composed the program.

The Society of Exploration Geophysicists held its meeting in the Huckins Hotel, presenting 32 papers in a 3-day program.

A pre-convention field party to study the Permian left Chickasha, Monday, and arrived in Oklahoma City, Tuesday night, March 21.

After the convention a field party visited the Arbuckle Mountains and the Ardmore basin.

Four conventions of the Association have been held in Oklahoma City: 1918, 1922, 1932, and 1939. The 1918 meeting was the first convention of the American Association of Petroleum Geologists, assembled under that name. (The 1918 meeting is generally known as the third annual meeting. The first annual meeting, at Norman, Oklahoma, in 1916, is recorded as a meeting of the geologists of the Southwest; the second annual meeting, in 1917, was a meeting of the Southwestern Association of Petroleum Geologists; and the third annual meeting was the 1918 Oklahoma City meeting when the name Southwestern had been replaced by the name American.) The attendance in 1918 was 125 members and associates. The 1922 meeting attendance is not on record; the total members and associates at that time numbered 631. The 1932 meeting was attended by 894 geologists, wives, and friends. Oklahoma City had become an oil town. In 1939, the twenty-fourth annual meet-



At the dinner dance in the Silver Glade Room of the Skirvin Tower Hotel, twenty-fourth annual meeting, Oklahoma City, March 23, 1939. Left to right: W. T. Born, Alex W. McCoy, III, Mary Ann Myers, Thomas E. Matson, Pauline Haulsee, Alex W. McCoy, Phyllis McCoy, Mrs. Ira H. Cram, Ira H. Cram, Mrs. D. C. Barton, D. C. Barton, Miss Gertrude Drach, H. B. Fuqua, W. H. Twenhofel, Mrs. W. H. Twenhofel, Geo. C. Matson, Mrs. Geo. C. Matson, Mrs. Frank R. Clark, Frank R. Clark, Mrs. A. I. Levorsen, A. I. Levorsen, W. E. Wrather, Mrs. W. B. Heroy, F. H. Lahee, Mrs. F. H. Lahee, W. B. Heroy, Alexander Deussen.

ing set a new high record for attendance, 1,858, the membership was at a new high, 2,951, and derricks were on the front lawns of the city and the Plaza of the Capitol. No city has entertained the Association more times than Oklahoma City. One of the ten past-presidents at this meeting, in reminiscing of the "good old days," while still enjoying the present, commented that the dinner-dance in the Silver Glade Room, Thursday night, was the prettiest party that he recalled since Bob Whitehead's in Dallas in 1926.

Registration

The twenty-fourth annual meeting made a new high record of attendance: 1,858 persons registered and were classified as 710 members, 121 associates, 642 non-member men, and 385 non-member women.

Election

The members elected the following officers to serve during the next 12 months: president, Henry A. Ley, Southern Cross Oil Company, San Antonio, Texas; vice-president, L. Murray Neumann, Carter Oil Company, Tulsa, Oklahoma; secretary-treasurer, Ed. W. Owen, L. H. Wentz (Oil Division), San Antonio, Texas; editor, W. A. Ver Wiebe (re-elected), University of Wichita, Wichita, Kansas.

The Association Division of Paleontology and Mineralogy (Society of Economic Paleontologists and Mineralogists) elected: president, Gayle Scott, Texas Christian University, Fort Worth, Texas; vice-president, Herschel L. Driver, Standard Oil Company of California, Los Angeles, California; secretary-treasurer, Henryk B. Stenzel, Bureau of Economic Geology, Austin, Texas.

The Association affiliate, the Society of Exploration Geophysicists, elected: president, E. A. Eckhardt, Gulf Research and Development Company, Pittsburgh, Pennsylvania; vice-president, W. T. Born (re-elected) Geophysical Research Corporation, Tulsa, Oklahoma; secretary-treasurer, J. H. Crowell, Independent Exploration Company, Houston, Texas; editor, R. D. Wyckoff, Gulf Oil Corporation, Houston, Texas.

Golf Tournament

The annual golf tournament was held at the Oklahoma City Golf and Country Club. There were 64 contestants, some of whom found the combination of golf game, election contest, technical program, and dinner-dance, all in one 24-hour day, quite too much. The winners follow.

Championship flight	Low gross	Jerome M. Westheimer
	Runner up	D. E. Mathes
	3rd low medalist	Glen S. Norville
1st flight	Net medal	A. C. Wright
	Runner up	Jack Montgomery
	3rd low medal	B. R. Vernon
2nd flight	Net medal	R. E. Shutt
	Runner up	Donald Goodwill, Jr.
3rd flight	Net medal	L. A. Johnston
	Runner up	J. K. Murphy
Low net prize		Robert H. Lynn
1st prize guest		Guy E. Smith
Guest runner up		Everett Johnson
Net low		W. J. Whatley

President
Henry A. Ley
San Antonio, Texas

Vice-President
L. Murray Neumann
Tulsa, Oklahoma

Past-President
D. C. Barton
Houston, Texas

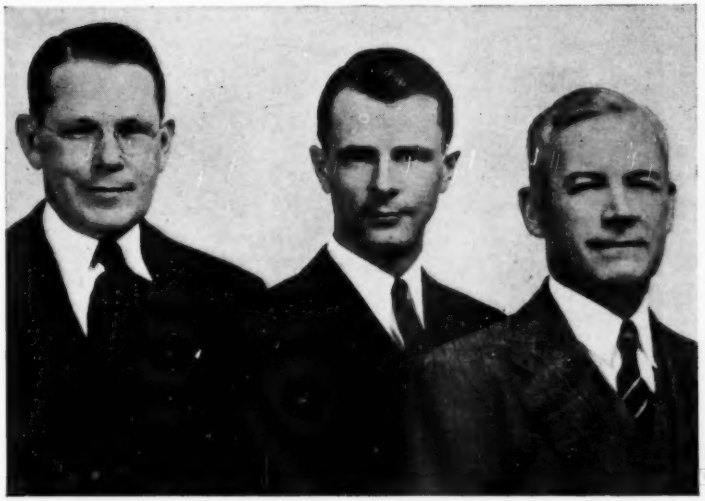
Secretary-treasurer
Ed. W. Owen
San Antonio, Texas

Editor
W. A. Ver Wiebe
Wichita, Kansas

S.E.P.M. President
Gayle Scott
Fort Worth, Texas

Officers elected at the twenty-fourth annual meeting, Oklahoma City, March 22–24, 1939.

(Photographs of Ley, Barton, and Scott by W. Ward Clark Studios; of Owen by Haddow-Marquis.



The general committee in charge of the twenty-fourth annual meeting at Oklahoma City, March 22–24, 1939. Left to right: John E. Van Dall, in charge of arrangements; R. W. Laughlin, chairman; J. T. Richards, in charge of technical program.

The member winner in the annual J. Wallace Bostick tournament is Jerome M. Westheimer (score, 80), of Ardmore. The guest winner of the Bostick cup is Guy E. Smith (score, 75), of Oklahoma City.

Executive Committee, 1938–1939

The executive committee, serving the Association during the year ending with the twenty-fourth annual meeting, were: chairman, Donald C. Barton, president of the Association; secretary, Ira H. Cram, secretary-treasurer of the Association; H. B. Fuqua, past-president, Harold W. Hoots, vice-president, and W. A. Ver Wiebe, editor.

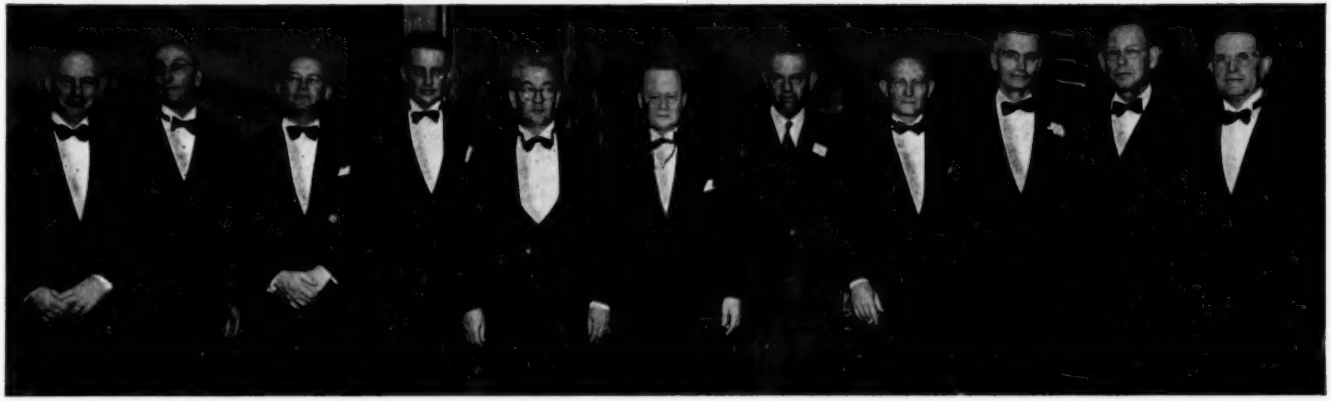
Convention Committees

General.—R. W. Laughlin, chairman; J. T. Richards, chairman in charge of technical program; John E. Van Dall, chairman in charge of arrangements.

Entertainment.—Jerry B. Newby, chairman. *Ladies.*—Wm. H. Atkinson and Mildred Armor Frizzell, chairmen; V. E. Monnett, Graydon H. Laughbaum, Irving Perrine, Willard L. Miller, M. E. Carpenter. *Dinner-Dance.*—Dan O. Howard, chairman; A. H. Richards, Albert S. Clinkscales, O. H. Kristofferson, Glenn Grimes, Gilbert W. Richards, Charles E. Ramsey, George H. Burress, Harold S. Thomas.

Exhibits.—I. Curtis Hicks, chairman; R. W. Harris, Hugh M. Eley, Gerald C. Maddox, Harold Jenkins, Jack Barton.

Field Trips.—Robert H. Dott, chairman; Charles E. Decker, Walter L. Moreman, John Fitts, C. W. Tomlinson, Don Hyatt, Lester L. Whiting, Vaughn W. Russom, Henry Schweer, Roger W. Sawyer, Maynard P. White, Joseph Neely.



Eleven presidents of the Association at Oklahoma City, March 23, 1939. Left to right:

W. B. Heroy, elected at Dallas, 1934. Now vice-president and chief geologist of the Pilgrim Exploration Company, Houston, Texas.
Geo. C. Matson, elected at Tulsa, 1921. Now geologist, Tulsa, Oklahoma.
H. B. Fuqua, elected at Los Angeles, 1937. Now in charge of North Texas division, Gulf Oil Corporation, Fort Worth, Texas.
A. I. Levorsen, elected at Wichita, 1935. Now consulting geologist, Tulsa, Oklahoma.
D. C. Barton, elected at New Orleans, 1938. Now research geologist, Humble Oil and Refining Corporation, Houston, Texas.
J. Elmer Thomas, elected at Tulsa, 1917. Now consultant, Houston, Texas.
Alexander Deussen, elected at Oklahoma City, 1918. Now consultant, Houston, Texas.
Alex W. McCoy, elected at Dallas, 1926. Now consultant, Royalty Building, Ponca City, Oklahoma
F. H. Lahee, elected at Oklahoma City, 1932. Now chief geologist, Sun Oil Company, Dallas, Texas.
W. E. Wrather, elected at Oklahoma City, 1922. Now consultant, Dallas, Texas.
Frank R. Clark, elected at Houston, 1933. Now vice-president and geologist, Ohio Oil Company, Tulsa, Oklahoma.

Finance.—Bob Hancock, chairman; Leland W. Jones, Burton L. Delleney, Clyde H. Dorr, Charles R. Walbert, Guard Scott Marvin, H. T. Brown.

Golf.—Roy Dale Jones, chairman; Kenneth A. Ellison, Coler A. Yoakam, R. H. Lynn, Millard Smith, Dean M. Stacy, W. C. Kite, Glen S. Norville.

Publicity.—Richard W. Camp, chairman; Hubert E. Bale, Claude V. Barrow, Grant McGee, Ralph A. Hockenson, Fred McDaniel, Jack M. Copass.

Registration and Reception.—D. A. McGee, chairman; Robert G. Hamilton, A. S. Montgomery, Fred C. Shields, R. L. Clifton, Lon B. Turk, C. E. Hamilton, R. A. Conkling, George T. McIntyre, D. W. Ohern.

Technical.—E. A. Paschal, chairman; C. T. Casebeer, George O. Williams, V. G. Hill, Rudolph W. Brauchli, T. A. Melton, F. Mabry Hoover, Leo J. Gude, Josef Faust, Harry E. Lillibridge, C. G. Lalicker.

Western Oklahoma Geological Societies

Oklahoma City Geological Society: president, Dan O. Howard; vice-president, Albert S. Clinkscales; secretary, Bob Hancock.

Shawnee Geological Society: president, Roy P. Lehman; vice-president, J. Lawrence Muir; secretary, T. M. Girdler, Jr.

Ardmore Geological Society: president, Don L. Hyatt; vice-president, J. P. Gill; secretary, W. Morris Guthrey.

Schedule of Events

MONDAY, MARCH 20

2:00 P.M. Registration. Lobby, Skirvin Tower Hotel
7:00 P.M. Executive Committee, Donald C. Barton, Chm. President's Suite, Skirvin Hotel

TUESDAY, MARCH 21

8:00 A.M. Registration. Lobby, Skirvin Tower Hotel
Scientific Exhibits. Mezzanine, Skirvin Tower Hotel
9:00 A.M. Committee on Application of Geology, Frank R. Clark, Chm. Parlor G, Mezzanine, Skirvin Hotel
10:00 A.M. Technical Session, Society of Exploration Geophysicists. Huckins Hotel
Executive and Finance Committees, A.A.P.G. President's Suite
Committee for Publication, F. H. Lahee, Chm. Japanese Room, Mezzanine, Skirvin Hotel
11:00 A.M. Research Committee, A. I. Levorsen, Chm. Green Room, Mezzanine, Skirvin Hotel
2:00 P.M. Annual Business Committee, Edgar W. Owen, Chm. Crystal Room, Mezzanine, Skirvin Hotel
Technical Session, Society of Exploration Geophysicists. Huckins Hotel
6:30 P.M. Informal dinner for geologists and ladies, sponsored by Research Committee. Empire Room, Skirvin Hotel
8:00 P.M. Open meeting, Research Committee, A. I. Levorsen, Chm. "The Tectonic Map of the United States." Crystal Room, Mezzanine, Skirvin Hotel

WEDNESDAY, MARCH 22

7:30 A.M. Registration. Lobby, Skirvin Tower Hotel
8:00 A.M. Scientific Exhibits. Mezzanine, Skirvin Tower Hotel
9:30 A.M. Opening General Session. Address of Welcome by the Honorable Reford Bond, Chairman, Corporation Commission of Oklahoma. Silver Glade Room, Skirvin Tower Hotel
9:30 A.M. General Technical and Joint Session with Society of Economic Paleontologists and Mineralogists and Society of Exploration Geophysicists, Silver Glade Room
1:30 P.M. Permian Symposium Technical Session. Silver Glade Room
2:00 P.M. Technical Session; Society of Exploration Geophysicists. Huckins Hotel

3:00 P.M. Ladies Get-Acquainted, Renew-Friendship Tea. Oklahoma Club
4:45 P.M. Announcements, Nomination of Officers, Appointment of Committees. General Session. Silver Glade Room
8:00 P.M. Permian Round Table. Crystal Room, Mezzanine, Skirvin Hotel

THURSDAY, MARCH 23

8:00 A.M. Registration. Lobby, Skirvin Tower Hotel
Scientific Exhibits. Mezzanine, Skirvin Tower Hotel
Committee on Geologic Names and Correlations, J. G. Bartram, Chm. Japanese Room, Mezzanine, Skirvin Hotel. Breakfast Meeting
Ballot Boxes open until 5:00 P.M. Headquarters Booth, Mezzanine, Skirvin Hotel
9:00 A.M. Mid-Continent Pennsylvanian Technical Session. Silver Glade Room, Skirvin Tower Hotel
10:00 A.M. Technical Session, Society of Economic Paleontologists and Mineralogists. Crystal Room, Mezzanine, Skirvin Hotel
Technical Session, Society of Exploration Geophysicists. Huckins Hotel
1:00 P.M. J. W. Bostick Golf Tournament. Oklahoma City Golf and Country Club. Green fees, $2.00 per person
1:30 P.M. Economics and Recent Development Technical Session. Silver Glade Room
Technical Session, S.E.P.M. Crystal Room
2:00 P.M. Technical Session, S.E.G. Huckins Hotel
Ladies. Play portrayal by Mrs. Madeline Douglas Bullard, at the Y.W.C.A.
3:00 P.M. Annual Business Meeting, S.E.P.M. Crystal Room
7:30 P.M. Banquet, followed by dancing. Silver Glade Room, Skirvin Tower Hotel. Per plate, $2.50 plus tax

FRIDAY, MARCH 24

8:00 A.M. Scientific Exhibits. Mezzanine, Skirvin Tower Hotel
9:00 A.M. Twenty-fourth Annual Business Meeting. Announcement of Elections. Silver Glade Room, Skirvin Tower Hotel
9:45 A.M. Mississippi Embayment Technical Session. Silver Glade Room
10:00 A.M. Executive Committees, 1938 and 1939, Joint Meeting. President's Suite
1:30 P.M. Eastern Interior Basin Technical Session. Silver Glade Room

SATURDAY, MARCH 25

7:45 A.M. One-day field trip to the Arbuckle Mountains and the Ardmore basin. Conducted by Charles E. Decker, University of Oklahoma. Lv. Monterey Cafe, Highway 77, south part of Norman, Oklahoma

TECHNICAL PROGRAM

GENERAL TECHNICAL SESSION

1. Honorable Reford Bond (chairman, Corporation Commission of Oklahoma, Oklahoma City, address of welcome
2. Donald C. Barton (president of the Association; research geologist, Humble Oil and Refining Co., Houston, Tex.), presidential address: Correlation of Crude Oils with Special Reference to the Gulf Coast Crude Oils
3. E. H. Sellards (president of the Society of Economic Paleontologists and Mineralogists; director of the Bureau of Economic Geology, University of Texas, Austin, Texas), presidential address: Some Vertebrate Fossils of the Texas Gulf Coastal Plain
4. F. M. Kannenstine (president, Society of Exploration Geophysicists; Kannenstine Laboratories and Independent Exploration Co., Houston, Tex.), presidential address: The Relationship of Geophysics to Geology
5. W. H. Twenhofel (University of Wisconsin, Madison, Wis.): The Origin of Black Shales
6. John G. Bartram (division geologist, Stanolind Oil and Gas Co., Tulsa, Okla.): Summary of Rocky Mountain Geology
7. Francis P. Shepard (associate professor, University of Illinois, Urbana; research associate, Scripps Institution of Oceanography, La Jolla, Calif.): Tectonic Developments off the California Coast
8. Malvin G. Hoffman (chief geologist, Midco Oil Corp., Tulsa, Okla.): The Role of Isostasy in Mountain Building
9. T. C. Hiestand (consulting geologist, Indian Territory Illuminating Oil Co.,

Bartlesville, Okla.) and P. B. Nichols (geological engineer, Indian Territory Illuminating Oil Co., Seminole, Okla.): Drilling-Time Data in Rotary Drilling

PERMIAN SYMPOSIUM

1. Carl O. Dunbar (professor of paleontology and stratigraphy, Yale University, New Haven, Conn.): The Permian System: Its Classification and Correlation
2. A. K. Miller (associate professor of geology, State University of Iowa) and W. M. Furnish (research associate in geology, State University of Iowa, Iowa City, Iowa): Permian Ammonoid Zones
3. Carl O. Dunbar (professor of paleontology and stratigraphy, Yale University, New Haven, Conn.): Fusuline Zones in the Late Paleozoic Systems
4. Arthur A. Baker (geologist, Geological Survey) and James Steele Williams (geologist, Geological Survey, U. S. Department of Interior, Washington, D. C.): The Permian in Parts of the Rocky Mountain and Colorado Plateau Regions
5. Geo. H. Norton (geologist, The Atlantic Refining Company, Wichita, Kan.): The Permian Red-Beds of Kansas
6. Sherwood Buckstaff (geologist, Shell Oil Co., Inc., Tulsa, Okla.): The Permian Sediments of Oklahoma
7. Norman D. Newell (assistant professor of geology, University of Wisconsin, Madison, Wis.), J. Brookes Knight (curator of Paleozoic invertebrates, Princeton University, Princeton, N. J.), Raymond C. Moore (State geologist and director, State Geological Survey, University of Kansas, Lawrence, Kan.), and Kenneth Brill (graduate student, University of Michigan, Ann Arbor, Mich.): Invertebrate Fauna of the Late Permian Whitehorse Sandstone
8. C. L. Mohr (research geologist, Indian Territory Illuminating Oil Co., Bartlesville, Okla.): Subsurface Cross Section of the Permian from Texas to Nebraska
9. George A. Kroenlin (geologist, Midland Exploration Company, Lovington, New Mex.): Salt, Potash, and Anhydrite in the Castile Formation of Southeast New Mexico
10. Clenon C. Hemsell (district geologist, Columbian Fuel Corp., Amarillo, Tex.): Geology of the Hugoton Gas Field of Southwestern Kansas
11. Garvin L. Taylor (geologist, Wichita, Kan.), John L. Garlough (geologist, Wichita, Kan.): Geology of the Southwest Kansas Gas Area
12. Glenn G. Bartle (dean, University of Kansas City), Rufus M. Smith (geologist, Panhandle Eastern Pipe Line Co., Kansas City, Mo.): The Lakin-Hugoton-Guymon Area of Kansas and Oklahoma
13. Henry Rogatz (consulting geologist, Amarillo, Tex.): The Geology of the Texas Panhandle Oil and Gas Fields
14. Taylor Cole (geologist, University Lands, Austin, Tex.): Heavy Minerals of the San Angelo Sandstone, Southern Midland Basin
15. John Emery Adams (geologist, Standard Oil Co. of Texas, Midland, Tex.): Structural Development, Yates Area
16. C. E. Needham (professor of geology and paleontology, School of Mines, Socorro, New Mex.): Structural Evolution of the Rio Grande Depression near Socorro, New Mexico
17. Philip B. King (associate geologist, Geological Survey, United States Department of the Interior, Washington, D. C.): The Older Rocks of the Van Horn Region, Texas

MID-CONTINENT-PENNSYLVANIAN SESSION

1. Robert H. Dott (director, Oklahoma Geological Survey, Norman, Okla.): Regional Stratigraphy of the Mid-Continent Area
2. Ira H. Cram (division geologist, The Pure Oil Co., Tulsa, Okla.): Regional Structure of the Mid-Continent Area
3. Thomas A. Hendricks (Geological Survey, Washington, D. C.): Geologic Interpretations of Gravity Anomalies in Atoka and Bryan Counties, Oklahoma
4. Charles E. Decker (professor of paleontology, University of Oklahoma, Norman, Okla.): (1) Basal Sedimentary Formations in the Wichita Mountains; (2) Carbonaceous and Asphaltic Material in the Lower Arbuckle Limestones of the Wichita Mountains
5. Kenneth K. Landes (State geologist and assistant director, Kansas Geological Survey, Lawrence, Kan.): Oil Production from Pre-Cambrian Rocks in Kansas
6. N. Wood Bass (Geological Survey, Tulsa, Okla.), Harold M. Smith (Bureau of Mines, Bartlesville, Okla.): Relationship of Crude Oils from the Mississippi Lime and the Shoestring Sands of the Cherokee Shale in Osage County, Oklahoma, and a part of Southeastern Kansas

7. H. S. McQueen (assistant State geologist, Missouri Geological Survey, Rolla, Mo.): Geology of the Forest City Basin
8. Carl A. Moore (Department of Geology, State University of Iowa, Iowa City, Iowa): Preliminary Report on the Morrow Group of Northeastern Oklahoma
9. Bruce H. Harlton (Amerada Petroleum Corp., Tulsa, Okla.): The Interpretation of Major Structural Features of the Northern Mid-Continent in Terms of Isostasy
10. F. B. Plummer and Bruce Grant (Bureau of Economic Geology, University of Texas, Austin, Tex.): Oil-Shale Deposits of Central Texas
11. Ray L. Six (professor of geology, Agricultural and Mechanical College, Stillwater, Okla.): Reagan Sandstone Sedimentation

ECONOMICS AND RECENT DEVELOPMENTS

1. Sidney A. Swensrud (assistant to the president, Standard Oil Company, Ohio, Cleveland, O.): The Relation between Crude Oil and Product Prices
2. Frederic H. Lahee (chief geologist, Sun Oil Co., Dallas, Tex.): Wildcat Drilling in 1938
3. H. P. Bybee (geologist, University Lands, Box 2101, University Station, Austin, Tex.), Berte R. Haigh (geologist, University Lands, Box 1663, Midland, Tex.), and Surce John Taylor (subsurface geologist, University Lands, Midland): Developments in West Texas and Southeastern New Mexico during 1938
4. Gentry Kidd (Stanolind Oil and Gas Co., San Antonio, Tex.): Developments in South Texas, 1938–1939
5. J. J. Maucini (geologist, Continental Oil Co., Wichita Falls, Tex.): North-Central Texas Developments, 1938
6. O. L. Brace (consulting geologist, 804 Second National Building, Houston, Tex.): Review of Developments in 1938, Gulf Coast of Southeast Texas and Louisiana
7. W. C. Spooner (consulting geologist, Atlas Building, Shreveport, La.): Developments in North Louisiana-South Arkansas, 1938
8. E. F. Shea (Stanolind Oil and Gas Co., Tulsa, Okla.): Developments in Oklahoma during 1938
9. Rycroft G. Moss (Phillips Petroleum Co., Wichita, Kan.): Developments in Kansas in 1938
10. Alfred H. Bell (Illinois State Geological Survey, Urbana, Ill.), George V. Cohee (Illinois State Geological Survey, Urbana, Ill.): Recent Developments in Illinois, with Special Reference to Formations below the McClosky
11. Harold W. Hoots (chief geologist, Richfield Oil Corp., Los Angeles, Calif.): Additions to Oil Reserves in California during 1938
12. J. M. Kirby (district geologist, The California Co., Denver, Colo.), H. N. Hickey (geologist, The California Co., Denver, Colo.): Developments in Rocky Mountain Region in 1938
13. Basil B. Zavoico (The Chase National Bank, Houston, Tex.): Foreign Developments during 1938
14. Frederick G. Clapp (consulting geologist, 50 Church St., New York): Geological Explorations in Eastern Iran
15. F. B. Plummer (University of Texas, Bureau of Economic Geology, Austin, Tex)., H. K. Livingston (University of Texas, Bureau of Economic Geology, Austin, Tex.): Importance of Capillary Phenomena in Oil Production
16. Wallace E. Pratt (director, Standard Oil Co., New Jersey, 30 Rockefeller Plaza, New York): The Basis of Proration in Texas
17. E. A. Wendlandt (Humble Oil and Refining Company, Tyler, Tex.) and G. W. Pirtle (Hudnall and Pirtle, Tyler, Tex.): Developments in East Texas during 1938.

MISSISSIPPI EMBAYMENT SESSION

1. John D. Todd (consulting geologist, Esperson Building, Houston, Tex.), Frank C. Roper (consulting geologist, Esperson Building, Houston, Texas): The Sparta-Wilcox Trend
2. J. C. Poole (Barnsdall Oil Co., Corpus Christi, Tex.): The Saxet Field, Nueces County, Texas
3. F. W. Rolshausen (Humble Oil and Refining Co., Houston, Tex.): Fossil Horizons of the Gulf Coast
4. Ed. J. Hamner (Humble Oil and Refining Co., Genoa, Tex.): Amelia Oil Field, Jefferson County, Texas
5. John M. Clayton (Gulf Oil Corp., Corpus Christi, Tex.): Producing Sands of South Texas above the Top of the Jackson Formation

6. M. Frank Reedy, Jr. (Dept. of Geology, University of Texas, Austin, Tex.): Subsurface Eocene Zones of the Gulf Coast
7. C. W. Sanders, Jr. (Shell Oil Co., Inc., Houston, Tex.): The Emba Salt-Dome Region, U.S.S.R., and Some Comparisons with Other Salt-Dome Regions
8. R. C. Bowles (Standard Oil Co. of Kansas, Houston, Tex.): Benavides Field, Duval County, Texas
9. R. J. Metcalf (Ohio Oil Co., Houston, Tex.): Deposition of the Lissie and Beaumont Formations of the Gulf Coast of Texas
10. C. Lathrop Herold (Shell Oil Co., Inc., Houston, Tex.): Geology of Sulphur Bluff Oil Field, Hopkins County, Texas
11. E. M. Rice (Pure Oil Co., Tyler, Tex.), F. J. Schempf (Stanolind Oil and Gas Co., Tyler, Tex.): Subsurface Correlations of the Lower Cretaceous (Comanche) of Central and East Texas

EASTERN INTERIOR BASIN SESSION

1. J. Marvin Weller (State Geological Survey, Urbana, Ill)., A. H. Sutton (Geology Department, University of Illinois, Urbana, Ill.): Mississippian Border of Eastern Interior Basin
2. L. E. Workman (Illinois State Geological Survey, Urbana, Ill.), J. Norman Payne (Illinois State Geological Survey, Urbana, Ill.): Subsurface Geology of the Mississippian System in Illinois (1) The Chester Series, by Workman; (2) The Iowa Series, by Payne
3. Lynn K. Lee (The Pure Oil Co., Olney, Ill.): The Geology of the Basin Fields in Southeastern Illinois—A Preliminary Report
4. H. H. Arnold, Jr. (The Texas Co., Tulsa, Okla.): The Salem Oil Field Area, Marion County, Illinois
5. L. M. Cline (Iowa Geological Survey, Ames, Iowa): A Comparison of the Pennsylvanian Des Moines Series of Southern Iowa and Northern Missouri

SOCIETY OF ECONOMIC PALEONTOLOGISTS AND MINERALOGISTS

1. A. K. Miller (associate professor of geology), and W. M. Furnish (research associate in geology, State University of Iowa, Iowa City, Iowa): Permian Ammonoid Zones
2. Carl O. Dunbar (professor of paleontology and stratigraphy, Yale University, New Haven, Conn.): Fusuline Zones in the Late Paleozoic Systems
3. Norman D. Newell (assistant professor of geology, University of Wisconsin, Madison, Wis.), J. Brookes Knight (curator of Paleozoic invertebrates, Princeton University, Princeton, N. J.), Raymond C. Moore (State geologist and director, State Geological Survey, University of Kansas, Lawrence, Kan.), Kenneth Brill (graduate student, University of Michigan, Ann Arbor, Mich.): Invertebrate Fauna of the Late Permian Whitehorse Sandstone
4. Charles E. Decker (professor of paleontology, University of Oklahoma, Norman, Okla.): Didymograptus protobifidus in North America
5. Charles E. Decker (professor of paleontology, University of Oklahoma, Norman, Okla.), Edward A. Frederickson (graduate student, University of Wisconsin, Madison, Wis.): A New Graptolite Horizon in Wisconsin
6. H. B. Stenzel (Bureau of Economic Geology, University of Texas, Austin, Tex.), R. W. Cumley (Bureau of Economic Geology, University of Texas, Austin, Tex.): A New Paleontologic Correlation Method
7. Daniel J. Jones (Phillips Petroleum Co., Bartlesville, Okla.): Conodont Fauna of the Seminole of Northeastern Oklahoma
8. Helen Tappan (graduate student, University of Oklahoma, Norman, Okla.): Foraminifera from the Grayson Formation of Northern Texas
9. Alva C. Ellisor (research geologist and paleontologist, Humble Oil and Refining Co., Houston, Tex.): An Interpretation of the Miocene Formation of South Louisiana
10. Donald W. Gravell (paleontologist, Gulf Oil Corp., Houston, Tex.), Marcus A. Hanna (paleontologist, Gulf Oil Corp., Houston, Tex.): Some New Species of Larger Foraminifera from the Claiborne of Mississippi
11. Flavy E. Davis (paleontologist, Gulf Oil Corp., Houston, Tex.): Some Species of Textularia from the Tertiary of Texas
12. J. B. Garrett (Stanolind Oil and Gas Co., Houston, Tex.): Some Middle Tertiary Smaller Foraminifera from Subsurface Beds of Jefferson County, Texas

13. Grover Murray, Jr. (Louisiana State University, Baton Rouge, La.): Ostracoda of the Genera Cytheredeis, Cytheropteron, Loxoconcha, and Brachycythere from the Gosport Sand, Claiborne Eocene, Claiborne Bluff, Alabama
14. Grover Murray, Jr. (Louisiana State University, Baton Rouge, La.), Keith M. Hussey (Louisiana State University, Baton Rouge, La.): Some Tertiary Species of the Ostracoda Genera Brachycythere and Alatacythere

SOCIETY OF EXPLORATION GEOPHYSICISTS

1. L. W. Gardner (Gulf Research and Development Company): An Areal Plan of Mapping Subsurface Structure by Refraction Shooting
2. H. M. Houghton (Geophysical Research Corporation): An Experimental Study of Changes in Reflection Character with Geophone Depth
3. W. M. Rust, Jr. (Humble Oil and Refining Company): The Physical Significance of Correlation Coefficients
4. M. Mott-Smith (Independent Exploration Company): Some Comparisons Between Straight and Curved Seismic Paths
5. Charles E. Houston (Humble Oil and Refining Company): Seismic Paths, Assuming a Parabolic Increase of Velocity with Depth
6. L. G. Howell, C. H. Kean, R. R. Thompson (Humble Oil and Refining Company): Some Experiments on the Characteristics of High Frequency Waves in the Earth
7. Barney Fisher (Coronado Corporation): La Rosa Field, A Geophysical Discovery
8. R. S. Dahlberg, Jr. (Carter Oil Company): Geophone Band Tests
9. F. F. Campbell (Geophysical Research Corporation): Dip Reflections on Two Gulf Coast Faults
10. Roland F. Beers (Geotechnical Corporation): Velocity Stratification as an Aid to Correlation
11. V. V. Vacquier (Gulf Research and Development Company): A Proposed Method For Orienting Cores
12. M. M. Slotnick (Humble Oil and Refining Company): A Note on a Device for Rapid Adjustment of Misclosures
13. L. L. Nettleton (Gulf Research and Development Company): Determination of Density for Reduction of Gravimeter Observations
14. S. Hammer (Gulf Research and Development Company): Terrain Corrections for Gravimeter Stations
15. Hart Brown (Brown Gravity-Meter Company): Model, Mechanism and Field Tests of a New Type Gravity-Meter
16. Paul F. Hawley (Stanolind Oil and Gas Company): Transients in Electrical Prospecting—II
17. P. W. Klipsch (Subterrex): Recent Developments in Eltran Prospecting
18. J. L. Lake (Subterrex): An Eltran Survey of Yoakum County, Texas
19. E. E. Blondeau (Geophysical Research Corporation): Shallow Resistivity Survey at South Elton, Louisiana
20. R. R. Thompson (Humble Oil and Refining Company): A Note on the Seismic Electric Effect
21. L. G. Howell and Alex Frosch (Humble Oil and Refining Company): Gamma-Ray Well-Logging
22. I. E. Rosenzweig (Institute of Electrotechnics at Lwow, Poland): The Electrical Model Method for Structural Investigations
23. Herbert Hoover, Jr. (United Geophysical Company): The Divining Rod
24. Clarence R. Dale (Dale Service Corporation) and Burton L. Delleney (Schlumberger Well Surveying Corporation): The Determination of Water Sources in Oil Wells
25. Eugene McDermott (Geophysical Service, Inc.): Concentrations of Hydrocarbons in the Earth
26. L. Horvitz (Subterrex): On Geo-Chemical Prospecting—I
27. E. E. Rosaire (Subterrex): On the Strategy and Tactics of Exploration for Petroleum—III
28. James B. Macelwane, S. J. (director, department of geophysics, St. Louis University): Geophysical Education in a Department of Geophysics
29. Dart Wantland (assistant professor of geophysics, Colorado School of Mines): Geophysical Education at an Engineering Institution
30. C. S. Piggott (Carnegie Institution of Washington): Core Samples from the Ocean Deeps

31. Eugene G. Leonardon and D. C. McCann (Schlumberger Well Surveying Corporation): Exploring Drill Holes by Sample Taking Bullets to Supplement Electrical Logging
32. Malvin G. Hoffman (Midco Oil Corporation): The Role of Isostasy in Mountain Building

MINUTES, TWENTY-FOURTH ANNUAL BUSINESS MEETING SKIRVIN HOTEL, OKLAHOMA CITY, OKLAHOMA MARCH 22–24, 1939

DONALD C. BARTON, *presiding*

The meeting was called to order at 4:45 P.M., March 22, 1939, by Donald C. Barton, president, Ira H. Cram serving as secretary.

1. *Nominations of officers.*—The president called for nominations of officers of the Association for the ensuing year. The following nominations were made.

For president:	IRA H. CRAM, nominated by C. L. Moody
	HENRY A. LEY, nominated by George S. Buchanan
For vice-president:	L. MURRAY NEUMANN, nominated by W. B. Wilson
For secretary-treasurer:	ED. W. OWEN, nominated by Frank A. Morgan
	E. FLOYD MILLER, nominated by D. A. McGee
For editor:	W. A. VER WIEBE, nominated by N. W. Bass.

There being only one nominee for the offices of vice-president and editor, the motion was made, seconded, and carried that the secretary be authorized to cast a unanimous ballot for the nominees for these offices.

2. *Ballot committee.*—A. I. Levorsen, chairman, A. R. Denison, and Alex W. McCoy were appointed by the president as a ballot committee.

3. *Resolutions committee.*—Frank A. Morgan, chairman, C. L. Moody, and Edward A. Koester were appointed by the president as a committee on resolutions.

The meeting was recessed at 5 P.M. until 9:15 A.M., March 24, 1939.

The recessed meeting was called to order at 9:15 A.M., March 24, 1939, by Donald C. Barton, presiding.

4. *Reading of minutes.*—It was moved, seconded, and carried that the reading of the minutes of the annual meeting held at New Orleans, Louisiana, March 16–18, 1938, be dispensed with inasmuch as they had been published in the Bulletin.

5. *Report of officers.*—The reports of president Donald C. Barton, editor W. A. Ver Wiebe, and secretary-treasurer Ira H. Cram were presented (Exhibits I, II, and III).

6. *Report of business committee.*—The report of the business committee (Exhibit IV) was read by chairman Ed. W. Owen. It was moved, seconded, and carried that the recommendations contained therein be adopted. (The reports of the committee on geologic names and correlations, John G. Bartram, chairman; of the research committee, A. I. Levorsen, chairman; of the committee on applications of geology, Frank R. Clark, chairman; of the committee for publication, F. H. Lahee, chairman; and of the representative of the Association on the National Research Council Division of Geology and Geography, F. H. Lahee, representative, appear as Exhibits V, VI, VII, VIII, and IX, respectively.)

7. *Report of resolutions committee.*—The report of the resolutions committee (Exhibit X) presented by Frank A. Morgan, chairman, was unanimously adopted.

8. *Report of ballot committee.*—Chairman A. I. Levorsen read the following report of the ballot committee.

Total number of ballots issued:		458
Total ballots cast:		455
For president:		
Henry A. Ley	229	
Ira H. Cram	226	
Total votes for president	455	
For secretary-treasurer:		
Ed. W. Owen	226	
E. Floyd Miller	219	
Total votes for secretary-treasurer	445	

9. *Introduction of new officers.*—The newly elected officers of the Association were introduced by retiring president Donald C. Barton.

10. The twenty-fourth annual meeting adjourned at 10 A.M.

DONALD C. BARTON, *president* IRA H. CRAM, *secretary*

EXHIBIT I. REPORT OF PRESIDENT

(Year Ending March 24, 1939)

The state of the Association is excellent; and no new deal is necessary for the Association to continue in a most healthy condition. The membership stands at an all-time high of approximately 3,000 members of all classes and is increasing. The income of the Association has healthily exceeded the expenditures during the past year by approximately $2,200. Financially, therefore, the Association's present program is reasonably balanced against the Association's income with a comfortable factor of safety. But the net excess of income over expense is not sufficient to justify expansion of the program without provision of new income. The *Bulletin*, as all members know, has maintained the high standards in quality and quantity that have prevailed for the past few years. The details in regard to the membership and the great increase of the numbers of members during the past year, in regard to the financial affairs of the Association, and in regard to the publications of the Association, will be found in the respective reports of the secretary-treasurer and of the editor.

The executive committee has not had a great deal of business before it during the past year. The business in the main has been routine in character. And no problem seriously affecting the Association has come up. The executive committee held only two meetings, the one at Oklahoma City early in the summer to discuss arrangements for the annual meeting with the officers and committee of the Oklahoma City Geological Society; the other at El Paso, at the time of the midyear meeting there.

The greatest activity of the executive committee has been in the consideration of the transfer of qualified men from associate to active membership. Contrary to the belief of many members, automatic transfer does not take place when an associate becomes eligible for active membership. An associate may apply for the transfer; and his application will then be passed upon by the executive committee; or the latter on their own initiative may

transfer any associate whom they believe eligible for active membership. During the depression years, the executive committees in general made no transfer unless it had been applied for by the associate. The present executive committee has had a definite program of transferring those associates who fully have the requisite qualifications for active membership.

The routine of the consideration of the transfers has been as follows. Under instructions from the executive committee, Mr. Hull has examined the files of the associates and has separated out all those who clearly are not eligible for active membership. For each of the remaining group of associates, a sheet giving a digest of the record of the associate's training, experience, and history is sent the rounds of the executive committee. If the associate is judged likely to be eligible for active membership, Mr. Hull is instructed to start the paper work of the transfer, which consists in getting three or more sponsors for the transfer, in getting the district representatives to express their opinion in regard to the transfer, and in getting the associate to bring his record up to date. The completed file on the transfer goes the rounds of the executive committee. If the latter approve the transfer, the names of the candidate and his sponsors are published in the *Bulletin*. The purpose of that publication of the applicant's name is to advertise the application to the membership, and if any member knows any good reason why the applicant would not make a desirable member of the Association, that member should make that reason known to the executive committee within 30 days. If no objections to the transfer have been registered with the executive committee, the associate is notified of his transfer to active membership.

The executive committee authorized the publication of a special volume comprising a symposium on recent sediments. This group of papers was solicited by the National Research Council committee on sedimentation from leading international authorities on various phases of the subject.

The executive committee recognized a project which ultimately will lead to a symposium volume on the American Permian.

At the request of the American Petroleum Institute, the Association has undertaken to prepare the geological chapter in the symposium digest, which the Institute is preparing, on the material available in America on the exploration for, and production of, petroleum.

The Association's relations with all affiliated societies are excellent. The executive committee informally renewed the invitation extended by the preceding executive committee to the Society of Exploration Geophysicists to establish headquarters at Tulsa in conjunction with the Association headquarters. But the dues of the Society are not sufficient to stand the overhead involved in the establishment of paid headquarters.

A most successful midyear meeting of the Association was held at El Paso, Texas, September 27–October 2, under the sponsorship of the West Texas Geological Society of Midland with the aid from other geological societies and from El Paso institutions. The thanks of the Association are particularly due to Berte R. Haigh and his committees for the well planned and carried out arrangements for the meeting, and to Ronald K. DeFord for the excellent technical program on the West Texas-New Mexico Permian basin. The total registration at the meeting was 386:206 members and associates, plus 105 men and 75 women who were not members of the Association. The majority of the technical papers given at the meeting, plus a few other papers, are to

be issued in the *Bulletin* later in the year as a symposium on the West Texas-New Mexico Permian basin.

Following the precedent of many of my predecessors, I visited many local societies: the Western Kentucky Geological Society at Owensboro, Kentucky, the Appalachian Geological Society at Charleston, West Virginia, the Michigan Geological Society at Mount Pleasant, Michigan, the Illinois Geological Society at Mattoon, Illinois, the field trip of the Kansas Geological Society and the Rocky Mountain Association of Petroleum Geologists in Colorado, the Shreveport Geological Society at Shreveport, Louisiana, the Panhandle Geological Society at Amarillo, Texas, the North Texas Geological Society at Wichita Falls, Texas, the Dallas Petroleum Geologists, the Tulsa Geological Society at its annual field day, the West Texas Geological Society at Midland, and the South Texas Section at Corpus Christi. Visits to several other of the local societies were precluded by my health. The visits of the president of the Association seem to be appreciated by all the societies. The visits to the outlying societies are particularly important, as the members of some of them do not realize that the Association is interested in them and their affairs and in the geology of their oil and gas fields.

I would like to bring several special subjects to the attention of the members of the Association.

Continued growth of the Association in the future will raise several problems. Our annual meeting already is so large that we can no longer meet at Shreveport, Louisiana. And if the Association grows to be much larger than it is at present, the possible meeting places will be even yet more restricted. Shall we then restrict the annual meeting places to the few cities with extra large available facilities; and I imagine that would mean in the main Houston and Dallas with an occasional visit to Los Angeles, New Orleans, and St. Louis? In that case, the Association will have to shoulder most of the burden of the arrangements for the meeting. Or shall we attempt to restrict the growth of the Association by raising the requirements for membership? Or shall we reluctantly restrict attendance at the annual meeting to members of the Association, their wives, and invited guests? Or shall we attempt to organize the annual meetings of certain of the local societies and sections as official regional midyear meetings of the Association? Attendance at the annual meeting might then be restricted; and attendance at the midyear meetings kept as unrestricted as at our present annual meetings. Any concerted drive for new members would seem to me unwise until those problems are thought out. I would like to see closer relations between oil geologists and petroleum engineers, for their fields and problems overlap considerably. But with the rapidly increasing number of petroleum engineers in the industry, the presence of a considerable part of them at our annual meeting, whether as members or as guests, will greatly complicate our problems in holding the annual meetings. The problems arising from further growth of the Association should be seriously considered.

The increasing importance of the district representatives in the functioning of the Association and the increasing amount of work required of representatives is not recognized by the membership at large. The business committee, which is composed mainly of the district representatives, was originally a steering committee for the annual business meeting of the Association, but it has evolved de facto into the legislative body of the As-

sociation. No longer, as in the old days, can the executive committee be in contact with most of the membership. And in the future, the executive committee and the association will have to depend much more upon the district representatives for contact with the individual members of the Association. The function of the district representatives in connection with consideration of applications for membership will be particularly important in the future. The applicant in general will be unknown to the executive committee; and his sponsors may be unknown or poorly known to them, or even more likely the dependability of the sponsors in sponsoring applications will be unknown to the executive committee. The district representative may know the applicant or his sponsors, and if necessary, he should be able to make contact with dependable members of the Association who do know the applicant. The future executive committee therefore probably will have to lean heavily upon the district representatives for advice in passing on many of the applications for membership.

To the newly elected district representatives I would like to bring the message, that your job is not going to be a cinch; and that the incoming executive committee and the following executive committees with whom you may serve will require much work from you.

To the various districts, I would like to bring the recommendation that in making nominations for the position of district representative, consideration be made whether the proposed nominee has the disposition and is in a position to do the work necessary.

The relations between the oil geologist and the petroleum engineer are worthy of consideration by the Association. The mechanical engineering phase of petroleum engineering is of little interest to the oil geologist, but that phase of petroleum engineering which deals with reservoir conditions, with the handling of the reservoir, and with production overlaps or makes contact with a great part of oil geology. At the midyear meeting at El Paso, Chester Naramore, permanent secretary of the Production Section, A. I. M. E., and I had considerable discussion of those relations and found ourselves in mutual agreement: (a) that a considerable part of the oil geologists should be more or less conversant with much of what the petroleum engineer is doing, and conversely a large part of the petroleum engineers would benefit by closer knowledge of oil geology; (b) that if a man can afford to join only one society, the petroleum engineer should join the Production Section of the A. I. M. E., and the oil geologist should join the Association, but that if a man can afford to join two societies, he should join the other society; and (c) that it would be well worth the while of both the oil geologists and the petroleum engineers to hold overlapping midyear meetings by the sections of the Production Section, A. I. M. E., and by the Association and affiliated societies.

The question whether or not the Association should not take closer interest in college geological societies is raised by the interest of the Production Section of the A. I. M. E. in building up A. I. M. E. student chapters at schools in the petroleum areas. No official interest has been taken by the Association in such societies. Levorsen's project of tours by prominent Association members to lecture at groups of colleges and universities is a promising but different method of attack on that problem of liaison with the colleges.

DONALD C. BARTON, *president*

Exhibit II. Report of Secretary-Treasurer
(Year Ending March 24, 1939)

MEMBERSHIP

On March 1, 1939, the membership of the Association was 2,951, a net increase of 305 since March 1, 1938. The net increase of 305 members compares favorably with last year's net increase of 315 members, which was the largest increase in any one year of the Association's history. Applications continue to come in and the executive committee is now considering 160 new applications and 11 applications for reinstatement. On March 1, 1935, the membership of 1,973 was the lowest since March 1, 1928, due to the depression. The phenomenal increase in membership of 978 since March 1, 1935, is in part due to the steadily increasing importance of geology to the petroleum industry, to the relative prosperity of that industry, and to the low dues.

It is the sad duty of the secretary to report the death of 12 members: Leslie A. Fisher, James H. Jenkins, R. V. Delehanty, Clyde M. Becker, Lloyd I. Yeager, M. E. Lake, Lamere John Dworak, Cecil L. Chatman, L. C. Hookway, A. C. Veatch, John Y. Snyder, and Karl Sundberg.

The data on membership are summarized in Tables I, II, and III. The distribution of members is, with some exceptions, much the same as it was last year. Texas still ranks first with 988 members. Oklahoma, California, and Louisiana rank next in the order named and the total number of members residing in these states is 47 less than the number of members residing in Texas. Kansas, which last year was in fourth place, is now in fifth place. The number of members residing in Illinois, Indiana, and Kentucky almost doubled during the year, being 71 on March 1, 1938, and 134 on March 1, 1939. This increase reflects the increased activity in these states. Outside of the United States the number of members residing in Venezuela (55) exceeds the combined membership of Colombia and the East Indies which rank next in the order named.

FINANCES

The audit published in the March, 1939, *Bulletin* and Tables IV, V, VI, and VII give the necessary data on the financial condition of the Association. Some explanation of the audit and tables is necessary because in the audit for the year ending December 31, 1938, investments were valued at the lower of cost or market whereas investments were carried at cost in the audit for the year ending December 31, 1937. The excess of cost over the lower of cost or market on December 31, 1938, of $5,718.43 was charged to income. On December 31, 1937, the excess of cost over the lower of cost or market was $8.506.73. Comparing the 1937 and 1938 audits it will be noted that total assets apparently decreased $1,196.39 during 1938. If investments had been carried at cost on the 1938 audit as they were on the 1937 audit, total assets would have increased $4,522.04. Also, if investments had been carried at the lower of cost or market in the 1937 audit, the increase in assets in 1938 would figure $7,310.34. Thus assets during 1938 actually increased $4,522.04 or $7,310.34 depending on whether one prefers to value investments at cost or the lower of cost or market.

Two other comparisons should be made. The audit reports a net loss for 1938 of $1,966.59 compared to a net income in 1937 of $4,481.28. Valuing investments at cost, this net loss becomes a net income of $3,751.84; or valuing

the investments in 1937 at the lower of cost or market, the 1937 net income of $4,481.28 becomes a loss of $4,025.45. Again depending upon how one prefers to value investments, net income in 1938 was either $729.44 less or $2,058.86 more than it was in 1937. Net operating income which is not affected by the investment account was $2,183.92 in 1938 compared to $843.64 in 1937, an increase of $1,340.28. It is gratifying that the Association has been able to operate successfully on the income from the reduced dues.

It is interesting to note that the cost of publishing the *Bulletin* decreased from 51½ cents per copy to 51⅛ cents per copy in 1938, but the members received a total of 105 pages more text than they did in 1937. Additional data on Association publications are summarized in Tables VIII and IX.

The market value of the Association's investments increased during 1938. The executive committee, following the advice of the Association's investment counsel, invested some $6,000 in additional securities. Income from investments decreased from the 1937 figure of $2,671.35 to $2,413.06 a decrease of $258.29. Dividend reductions and the retirement of some high-coupon bonds account for the decrease. Only one bond and one common stock of the investment portfolio do not pay dividends.

At the close of 1938 the investments of the Association were diversified as follows.

Type	*Cost*	*Per Cent*	*Annual Income*
Morris Plan	$ 3,769.09	6.0	$ 151.00
Bonds	32,985.23	52.2	1,291.00
Preferred stocks	3,858.24	6.1	180.00
Common stocks	22,565.16	35.7	913.00
	$63,177.72	100.0	$2,535.00

The annual income of $2,535 is at the rate of 4.01 per cent on the investment.

BUDGET

Income and expenses for 1939 have been estimated and are listed in Table X. Total income is estimated at $48,900, and total expenses at $44,000.

EXECUTIVE COMMITTEE MEETINGS

The executive committee met during the New Orleans and Oklahoma City conventions and during the El Paso midyear meeting to transact Association business. The committee also met in Oklahoma City to make plans for the 1939 convention.

HEADQUARTERS OFFICE

In 1937 the Society of Economic Paleontologists and Mineralogists established a headquarters office adjoining the Association offices. Their work is being carried on under the direction of business manager Hull, and the arrangement is working nicely.

ACKNOWLEDGMENTS

The secretary-treasurer takes this opportunity to express his sincere appreciation to the executive committee, the headquarters office and the various Association committees for their splendid coöperation.

IRA H. CRAM, *secretary-treasurer*

TABLE I

Total Membership by Years

May 19, 1917	94	March 1, 1929	2,126
February 15, 1918	176	March 1, 1930	2,292
March 15, 1919	348	March 1, 1931	2,562
March 18, 1920	543	March 1, 1932	2,558
March 15, 1921	621	March 1, 1933	2,336
March 8, 1922	767	March 1, 1934	2,043
March 20, 1923	901	March 1, 1935	1,973
March 20, 1924	1,080	March 1, 1936	2,169
March 21, 1925	1,253	March 1, 1937	2,331
March 20, 1926	1,504	March 1, 1938	2,646
March 1, 1927	1,670	March 1, 1939	2,951
March 1, 1928	1,952		

TABLE II

Comparative Data of Membership

	March 1, 1938		*March 1, 1939*	
Number of honorary members	16		16	
Number of life members	2		3	
Number of members	2,064		2,287	
Number of associates	564		645	
Total number of members and associates		2,646		2,951
Increase in membership		315		305
Members and associates	262		334	
Reinstatements	92		53	
Total new members and reinstatements		354		387
Applicants elected, dues unpaid	24		27	
Applicants approved for publication	70		55	
Recent applications	63		78	
Total applications on hand		157		160
Applicants for reinstatement, elected, dues unpaid	11		8	
Recent applications for reinstatement	9		3	
Total applications for reinstatement on hand		20		11
Applicants approved for transfer, dues unpaid	1		28	
Applicants for transfer approved for publication	12		14	
Recent applications for transfer on hand	7		37	
Total applications for transfer on hand		20		79
Number of members and associates resigned	6		11	
Number of members and associates dropped	25		60	
Number of members died	8		11	
Total loss in membership		39		82
Total gain in membership		315		305
Number of members and associates in arrears, previous year	91		80	
Members in arrears, current year	645		766	
Associates in arrears, current year	147		215	
Total number members and associates in arrears current year		792		981
Total number members and associates in good standing		1,763		1,890

TABLE III

GEOGRAPHIC DISTRIBUTION OF MEMBERS
March 1, 1939

Alabama	4	Kentucky	27	Ohio	12
Arizona	3	Louisiana	142	Oklahoma	434
Arkansas	14	Maine	2	Oregon	2
California	365	Maryland	6	Pennsylvania	56
Colorado	43	Massachusetts	9	South Dakota	3
Connecticut	2	Michigan	24	Tennessee	6
Delaware	1	Minnesota	3	Texas	988
Dist. of Columbia	35	Mississippi	4	Utah	3
Florida	5	Missouri	28	Vermont	1
Georgia	1	Montana	9	Virginia	2
Illinois	87	Nebraska	5	Washington	5
Indiana	20	New Jersey	7	West Virginia	20
Iowa	4	New Mexico	22	Wisconsin	2
Kansas	135	New York	78	Wyoming	15
		N. Carolina	4		

Total members in United States 2,638

Arabia	1	England	20	Peru	2
Argentina	11	France	6	Philippine Is.	3
Australia	9	Germany	8	Poland	2
Austria	1	Hungary	1	Roumania	9
Belgian Congo	1	India	4	Scotland	2
Belgium	1	Iraq	3	Sweden	1
Burma	1	Italy	4	Switzerland	10
Canada	21	Japan	3	Syria	2
Central America	2	Madagascar	1	Turkey	4
Colombia	26	Mexico	10	Uganda	1
Cyprus	1	Morocco	1	Union of So. Africa	1
Denmark	2	Netherlands	23	Uruguay	1
East Indies	25	New Zealand	5	U.S.S.R.	1
Ecuador	2	Palestine	2	Venezuela	55
Egypt	9	Persia (Gulf)	2	West Indies	13

Total members in foreign countries 313

Grand total 2,951

TABLE IV

COMPARISON OF ACCRUED INCOME BY CALENDAR YEARS

Dues	*1936*	*1937*	*1938*
Members	$18,410.00	$19,880.00	$22,170.00
Associates	3,042.00	3,546.00	4,408.00
Total	$21,452.00	$23,426.00	$26,578.00
Bulletin			
Subscriptions	$ 4,072.64	$ 4,531.94	$ 4,376.96
Advertising	5,994.34	7,084.95	7,093.72
Total	$10,066.98	$11,616.89	$11,470.68
Back Numbers, etc.			
Bound Volumes of Bulletin	$ 2,449.84	$ 2,911.60	$ 2,533.93
Back Numbers of Bulletin	1,097.87	1,136.97	858.10
Other Publications	55.33	170.70	66.34
Total	$ 3,603.04	$ 4,219.27	$ 3,458.37

TABLE IV—(Continued)

Special Publications			
Structure Volume I*	$ 621.53	$ 135.30	$ —
Structure Volume II	697.36	617.05	439.52
Geology of California*	578.65	196.24	—
Problems of Petroleum Geology	1,200.88	1,023.80	639.88
Geology of Natural Gas*	2,131.65	917.14	616.38
Geology of Tampico Region	1,633.60	667.46	172.67
Index	—	448.36	115.04
Gulf Coast*	—	4,197.86	743.44
Struct. Evol. Sou. California*	—	1,117.13	299.44
Tectonic Map*	—	107.87	21.90
Miocene Strat. of California*	—	—	368.00
Total	$ 6,863.67	$ 9,428.21	$ 3,416.27
Other Income			
Convention Receipts (Net)	$ 112.51	$ —	$ —
Delinquent Dues Charged Off	567.00	544.00	118.00
Interest	1,749.67	2,074.47	1,901.26
[1]	63.65	65.63	74.14
*	519.36	501.78	437.66
Miscellaneous	32.05	29.47	83.33
Sale of library	535.25	56.50	—
Members Reinstated	167.85	210.10	144.77
Bad Debt, Back Int., Recovered	257.33	160.00	—
Cancellation Investment Reserve	1,895.41	—	—
Inventory Increase	—	1,313.87	733.38
Contributions[1]	—	—	300.00
Total	$47,885.77	$53,646.19	$48,715.86

* Income of Publication Fund.
[1] Income of Research Fund.

TABLE V

COMPARISON OF ACCRUED EXPENSES BY YEARS

General and Administrative Expenses	*1936*	*1937*	*1938*
Salaries—Manager	$ 1,783.04	$ 2,782.50	$ 2,840.00
Clerical	5,459.08	5,675.69	5,762.62
Rent	1,120.00	1,460.00	1,500.00
Telephone and Telegraph	342.35	444.58	249.51
Postage	1,117.32	1,315.62	1,675.30
Office Supplies and Expenses	813.31	501.51	448.73
Printing and Stationery	321.47	440.16	408.05
Audit Expense	300.00	300.00	300.00
Insurance and Taxes	163.58	155.14	179.28
Convention Expense	—	388.25	80.84
Freight and Express (Shipments from Tulsa)	178.76	254.17	128.03
Exchange and Refunds	13.97	—	—
Bad Debts	—	—	408.76
Donations—Soc. Econ. Paleon. and Min.	500.00	500.00	—
Soc. Economic Geologists	250.00	250.00	—
Miscellaneous	14.51	253.76	360.29
Depreciation—Furniture and Fixtures	374.07	393.39	388.03
Investment Counsel	200.00	400.00	400.00
Loss on sale of Bonds, etc. (Net)	28.98	4.31	1,491.24
Excess of cost of Investments over Lower of Cost or Market, Dec. 31, 1938	—	—	5,718.43
	$12,980.44	$15,519.08	$22,339.11
Less Expenses charged Soc. Econ. Paleon. and Min.	—	—	702.81
Total	$12,980.44	$15,519.08	$21,636.30

TABLE V—(Continued)

Publication Expenses			
Salaries—Manager	$ 2,700.00	$ 2,925.00	$ 3,000.00
Editorial	1,550.60	3,495.22	4,840.00
Printing Bulletin	11,554.05	12,144.88	12,778.54
Engravings	1,694.44	1,695.20	1,945.66
Separates	261.98	246.59	149.04
Stencils and Mailing	167.47	184.36	229.54
Binding Bulletins	341.75	409.04	491.10
Postage and Express (Bulletins)	801.89	887.76	962.08
Copyright Fees	24.00	24.00	24.00
Freight, Express, Postage (Other Publications) Shipments from printers	677.64	1,343.55	460.02
Discounts	78.00	51.97	13.53
Purchase of Back Numbers	49.00	—	—
Bad Debts	97.40	269.31	7.19
Miscellaneous	244.81	169.48	10.59
Special Publications	6,830.69	9,799.47	4,134.86
Refunds—Unavailable Bulletins	347.00	—	—
Obsolescence of Printed Matter	319.05	—	—
Bulletin Inventory Decrease	2,597.80	—	—
Total	$30,337.57	$33,645.83	$29,046.15
Total Expense	$43,318.01	$49,164.91	$50,682.45

TABLE VI

COMPARISON OF NET INCOME BY YEARS

	1936	*1937*	*1938*
Accrued Income	$47,885.77	$53,646.19	$48,715.86
Expenses			
General and Administrative	12,980.44	15,788.39	21,636.30
Publication	30,337.57	33,376.52	29,046.15
Total	$43,318.01	$49,164.91	$50,682.45
Excess Income over Expenses	$ 4,567.76	$ 4,481.28	—$ 1,966.59

TABLE VII

INVESTMENTS

	Cost	*Market Value End of Year*
1936 Values		
General Fund	$41,707.03	$43,255.77
Publication Fund	12,635.94	14,097.03
Research Fund	1,480.16	1,568.15
Total	$55,823.13	$58,920.95
1937 Values		
General Fund	$44,431.55	$38,288.12
Publication Fund	12,712.46	11,397.84
Research Fund	1,545.57	1,449.93
Total	$58,689.58	$51,135.89
1938 Values		
General Fund	$49,438.27	$45,485.20
Publication Fund	11,843.40	11,634.90
Research Fund	1,896.05	1,738.55
Total	$63,177.72	$58,858.65

TABLE VIII

COMPARISON OF COST OF BULLETIN

	1936	1937	1938
Total Expenses	$18,994.39	$21,663.21	$23,939.45
Monthly Edition	3,200	3,500	3,900
Total Copies Printed	38,400	42,000	46,800
Total Pages of Text, Including Covers	2,094	2,061	2,174
Total Pages of Text	1,722	1,641	1,746
Total Cost Per Copy	0.50	0.515	0.512

TABLE IX

(Section 1)

SPECIAL PUBLICATIONS

	Structure Vol. II	*Problems Petrol. Geology*	*Geology Natural Gas*	*Geology Tampico Region*	*Gulf Coast Oil Fields*	*Total*
Inventory						
Dec. 31, 1937	$ 950.40	$ 374.65	$3,528.00	$1,990.01	$2,062.12	$8,905.18
Dec. 31, 1938	655.20	14.75	2,964.00	1,873.22	1,649.70	7,156.87
Sales	439.52	639.88	616.38	172.67	743.44	2,611.89
Total Edition	2,500	2,034	2,500	1,575	2,510	
Copies on Hand						
Dec. 31, 1937	264	127	882	869	1,175	
Dec. 31, 1938	182	5	741	818	940	
Number of Pages	780	1,073	1,227	280	1,070	
Cost (inventory) per Copy	$3.60	$2.95	$4.00	$2.29	$1.755	
Selling Price, when Issued, per Copy	4.00	5.00	4.50	3.50	4.00	
Present Selling Price						
Members and Associates	5.00	—	4.50	3.50	3.00	
Non-Members	7.00	—	6.00	4.50	4.00	

TABLE IX

(Section 2)

SPECIAL PUBLICATIONS

	Comprehensive Index		*Struc. Evolution Southern California*	*Tectonic Map, Southern California*	*Miocene Stratig. of California*	*Total*
	Cloth	*Paper*				
Inventory						
Dec. 31, 1937	$ 265.95	$2,033.50	$ 394.58	$ 56.64	$ —	$2,750.67
Dec. 31, 1938	—	1,513.92	214.73	53.12	3,450.15	5,231.92
Sales	—	115.04	209.44	21.90	368.00	804.38
Total Edition	2,837	1,271	1,047	940	1,530	
Copies on Hand						
Dec. 31, 1937	154	1,225	362	708	—	
Dec. 31, 1938	—	912	197	664	1,394	
Number of Pages	382	382	157	—	450	
Cost (inventory) per Copy	$1.727	$1.66	$1.09	$0.08	$2.475	
Selling Price, when Issued, per Copy						
Members and Associates	2.00	—	2.00	.50	4.50	
Non-Members	3.00	—	2.00	.50	5.00	
Present Selling Price						
Members and Associates	—	2.00	2.00	.50	4.50	
Non-Members	—	3.00	2.00	.50	5.00	

TABLE X

BUDGET, 1939

Revenues	*1937*	*1938*	*Estimated 1939*
Dues	$23,426.00	$26,578.00	$27,000.00
Bulletin			
Subscriptions	4,531.94	4,376.96	4,000.00
Advertising	7,084.95	7,093.72	7,000.00
Bound Volumes	2,911.60	2,533.93	2,500.00
Back Numbers	1,136.97	858.10	800.00
Special Publications			
Structure Volume I	135.30	—	—
Structure Volume II	617.05	439.52	500.00
Geology of California	196.24	—	—
Problems of Petroleum Geology	1,023.80	639.88	—
Geology of Natural Gas	917.14	616.38	500.00
Geology of Tampico Region	667.46	172.67	100.00
Comprehensive Index	448.36	115.04	100.00
Gulf Coast Oil Fields	4,197.86	743.44	350.00
Struc. Evol. Southern California	1,117.13	299.44	150.00
Miocene Stratigraphy of California	—	368.00	1,500.00
Other Publications	278.57	88.24	100.00
Recent Marine Sediments	—	—	1,500.00
Other Income			
Accounts Charged Off and Misc.	760.50	346.10	300.00
Income from Investments	2,641.88	2,413.06	2,500.00
Total	$52,092.75	$49,682.48	$48,900.00
Expenses			
General Administrative	$15,395.83	$14,366.51	$15,000.00
Publication (exclusive of following books)	24,689.90	24,890.57	25,000.00
Miocene Stratigraphy of California	—	3,786.77	—
Comprehensive Index	3,360.98	—	—
Struc. Evol. Southern California	1,220.65	—	—
Gulf Coast Oil Fields	4,104.99	348.09	—
Recent Marine Sediments	—	—	4,000.00
Total	$48,772.35	$43,391.94	$44,000.00

EXHIBIT III. REPORT OF EDITOR

During the year just past, extending from the month of March, 1938, to March, 1939, the *Bulletin* of the Association has apparently satisfied our large membership. In order to accomplish this the editorial board has received and prepared for publication no less than 71 major papers. A tabular summary of the contents of these major papers indicates that we have the full coöperation of members in every part of the United States as well as in other countries. The Appalachian district contributed eight articles among which was one comprehensive summary of the petroleum geology of the region. We were also fortunate enough to secure a comprehensive paper on the Michigan basin as well as a broad regional paper involving the stratigraphy of the eastern part of the United States.

The Mid-Continent area was represented by five Oklahoma papers, one stratigraphic paper on southern Arkansas, six excellent papers from Louisiana, one stratigraphic paper on Kansas, and three very inclusive papers on the general geology of the Gulf Coast region. Our knowledge of the detailed geology of southwestern Texas was further expanded by two articles. In the Rocky Mountain states one pool was described from Colorado and three interesting prospective petroleum areas were described from New Mexico and Utah. Canada received attention by means of a complete summary of the

data regarding the remarkable oil sand of the McMurray region. Three articles on the Pacific Coast region will serve to permanently increase our knowledge of the Santa Maria district as well as several more restricted areas.

Our readers have no doubt noticed that the information sent in is grouped under the following headings: *Geological Notes*, *Discussion*, *Reviews and New Publications*, *Association Round Table*, *Memorials*, *Research Notes*, and *At Home and Abroad*.

Many of the most valuable fragments of information are published under one or another of these headings. It has been the hope of the editor that these might be expanded during the year, and he is happy to report that this has been the case. For instance, our *Geological Notes* have contained 22 contributions this year. They involve such items as new deep sand discoveries, stratigraphic records of deep test wells in various parts of the country, interesting historical data of the beginnings of our science of petroleum geology, significant new developments in connection with correlations or stratigraphy, unexpected or remarkable structural data, *et cetera*. This department could be expanded still more without encroaching on our space. Therefore, I should like to insert at this point a most emphatic invitation to each one of you to send in similar data. They may be facts well known in a certain district because of the quick interchange of information among company men; however, to another geologist in another district they will be news.

During the year seven members sent in contributions which were published under the heading of *Discussion*. This department also could be expanded greatly to the benefit of the Association. The editorial board is fully aware of the fact that erroneous statements appear in some of the articles, despite the fact that they are read by a number of well informed men before they are printed. Such misstatements should be corrected in subsequent issues. Furthermore, authors welcome corrections of this type.

A new departure this year is the short editorial by former presidents of the Association. Two of these have appeared and have received favorable comment. We should like to be able to publish more of these. In a rapidly changing world, the problems of the petroleum geologist are also changing, perhaps even more rapidly. The younger members of our Association welcome the thoughts and predictions of the older men who have seen many of these changes develop during their careers. Let us have more of them.

In addition to the *Bulletin*, the Association also sponsors the publication of special monographs. Only one of these has appeared during the past year —the *Miocene Stratigraphy of California*. Work has started on another which it is hoped will lay a new foundation for the understanding of sedimentation. It is in the form of a symposium on *Recent Marine Sediments* and consists of 34 special articles written by as many individual authors each of whom is recognized as one of the world's authorities.

The editor wishes to reiterate two things which were emphasized in last year's report. First, please do not hesitate to write letters indicating your preferences in regard to the material you would like to see in the *Bulletin*. Second, please write something regarding the geology of the area in which you work and send it in as soon as possible. We would like very much to add your name to the list of authors who are making the *Bulletin* one of the first-rank technical journals of the world.

For the excellence as well as the number of the articles, too much credit can not be given to the committee on publication. From the editor's experience extending over the past 2 years it now appears quite impossible to secure

enough papers of a high quality without the aid of this committee. The editor hopes that the committee will continue to render service as wholeheartedly and as enthusiastically as it has done in the past.

TABLE I

GEOGRAPHICAL DISTRIBUTION OF ARTICLES

Texas	14	Mississippi	3
Appalachian states	8	Colorado	3
Oklahoma	6	Utah	3
Louisiana	4	Eastern Interior	2

One in each of the following: Alabama, Arkansas, Canada, Colorado, Florida, Kansas, Michigan, Missouri, New Mexico, Venezuela

Although the annual convention each year contains a great many papers of interest to the members, many of these are never sent in for publication. Table II has been prepared to show the percentage of papers which have been sent in from the Los Angeles and the New Orleans conventions.

TABLE II

Papers read at Los Angeles convention	52
Papers printed in BULLETIN	30 (57 per cent)
Papers not sent in by authors	22 (42 per cent)
Papers read at New Orleans convention	99
Papers printed in BULLETIN	45 (45 per cent)
Papers not sent in by authors	54 (55 per cent)

TABLE III

1938 BULLETIN PAGES BY MONTHS

Month	*Majors*	*Minors*	*Majors & Minors*	*Advertising & Miscellaneous*	*Total*
January	99	29	128	28	156
February	88	24	112	32	144
March	65	87	152	28	180
April	97	27	124	32	156
May	57	59	116	32	148
June	130	26	156	32	188
July	126	38	164	28	192
August	148	32	180	28	208
September	139	33	172	32	204
October	142	26	168	32	200
November	127	29	156	28	184
December	58	60	118	48	166
Total	1,276	470	1,746	380	2,126
Monthly Average	106.3	39.1	145.5	31.6	177.1

TABLE IV

TOTAL BULLETIN PAGES AND CONTENTS BY YEARS

	1936	*1937*	*1938*
Pages of major articles	1,300	1,191	1,276
Pages of minor articles	422	450	470
Pages of majors & minors	1,722	1,641	1,746
Pages of advertising, etc.	308	372	380
Total pages	2,046	2,013	2,126
Number of illustrations	372	388	378
Number of major articles	61	70	70
Number of minor articles*	74	83	70

* Minor articles: geological notes, discussions, reviews, memorials.

W. A. VER WIEBE, *editor*

EXHIBIT IV. REPORT (MINUTES) OF BUSINESS COMMITTEE

Skirvin Hotel, Oklahoma City, Oklahoma, March 21, 1939

The meeting was called to order at 2:15 P.M. by Ed. W. Owen, chairman. The following members were present.

Executive committee: Donald C. Barton, Harold W. Hoots, Ira H. Cram, W. A. Ver Wiebe, H. B. Fuqua

Members-at-large: John L. Garlough, Berte R. Haigh, C. J. Hares, A. I. Levorsen, Frank A. Morgan

Division of Paleontology: Not represented

District Representatives:

Amarillo: Carl C. Anderson represented by C. J. Peterson
Appalachian: Paul H. Price represented by Coleman D. Hunter
Canada: not represented
Capital: Arthur A. Baker
Dallas: P. W. McFarland represented by R. E. Rettger
East Oklahoma: R. B. Rutledge, W. B. Wilson
Fort Worth: Charles E. Yager
Great Lakes: Benjamin F. Hake
Houston: Orval L. Brace, David Perry Olcott
Mexico: William A. Baker, Jr.
New Mexico: Harold S. Cave
New York: W. T. Thom, Jr.
Pacific Coast: A. Arthur Curtice represented by H. L. Driver; Homer J. Steiny; E. J. Bartosh
Rocky Mountains: J. Harlan Johnson
Shreveport: A. F. Crider represented by C. L. Moody
South America: not represented
So. Permian Basin: Cary P. Butcher represented by Jesse E. Simmons
South Texas: Fred P. Shayes
Tyler: A. C. Wright
West Oklahoma: not represented
Wichita: Edward A. Koester
Wichita Falls: not represented

1. *Minutes of previous meeting.*—It was moved, seconded, and carried that the reading of the minutes of the last meeting of the committee be omittted, as the minutes had been published in the *Bulletin.*

The reports of the following committees were read.

2. *Report of the representative of the Association on Division of Geology and Geography, National Research Council,* F. H. Lahee, representative.

3. *Report of the committee for publication,* F. H. Lahee, chairman.

4. *Report of the committee on applications of geology,* Frank R. Clark, chairman.

5. *Report of the research committee,* A. I. Levorsen, chairman.

6. *Report of the committee on geologic names and correlations,* John G. Bartram, chairman, was not read, but was recommended for publication in the *Bulletin.*

After the reading of the reports it was moved, seconded, and carried that the reports be accepted and referred to the annual business meeting with the

recommendation that they be not read but that they be published in the May, 1939, *Bulletin*.

7. *Research committee resolution.*—It was moved, seconded, and carried that the following resolution by the research committee be adopted and referred to the annual business meeting with the recommendation that the Association formally adopt it.

Whereas, the proposal of the Houston Geological Society to secure samples from the floor of the Gulf of Mexico through the assistance of the U. S. Coast and Geodetic Survey is one of wide interest and importance to petroleum geology, we therefore strongly recommend the official approval of our Association be given this project.

8. It was moved, seconded, and carried that the research committee's recommendation that $1,000 be appropriated annually is appropriate and that the executive committee make further study of the recommendation.

9. It was moved, seconded, and carried that the committee recommends to the annual meeting the adoption of the following by-laws as a substitute for Article VI of the present by-laws.

ARTICLE VI. COMMITTEES

Appointment and Tenure

SECTION 1. There shall be the following standing committees:

Business Committee
Research Committee
Committee on Geologic Names and Correlations
Committee on Applications of Geology
Committee for Publication
Finance Committee
Trustees of Revolving Publication Fund
Trustees of Research Fund

The president shall appoint all standing committees except the business committee, for which provision is hereafter made. Members of all committees except the business committee shall serve for a three-year term, but in rotation, with one-third of the members being appointed each year. The president shall designate the chairmen annually, shall have power to fill vacancies, and shall notify the members of the committees of their appointment. The president may designate one or more vice-chairmen annually.

In addition to the aforesaid standing committees, the president shall appoint annually or semiannually a resolutions committee, and such special committees as the executive committee may authorize. Special committees shall be appointed for a term of one year. The president shall designate the chairmen of such committees.

Business Committee

SECTION 2. The business committee shall act as a council and advisory board to the executive committee and the Association. This committee shall consist of the executive committee, not more than five members at large appointed annually by the president, two members elected by and from each technical division, and the district representatives. The president shall also appoint annually a chairman and a vice-chairman, but neither of these need be one of those otherwise constituting the business committee. The secretary-treasurer shall act as secretary of the business committee. If a district or technical representative is unable to be present at any meeting of the committee he may designate an alternate, who, in the case of a district representative, may or may not be a resident of the district he is asked to represent, and the alternate, on presentation of such a designation in writing, shall have the same powers and privileges as a regularly chosen representative. The business committee shall meet the day before the annual meeting at which all proposed changes in the constitution or by-laws shall be considered, all old and new business shall be discussed, and recommendations shall be voted for presentation at the annual meeting.

Research Committee

SECTION 3. The purpose of the research committee is the advancement of research, particularly within the field of petroleum geology. The committee shall consist of twenty-four members unless a different number is authorized by the executive committee.

Committee on Geologic Names and Correlations

SECTION 4. The purpose of the committee on geologic names and correlations is to lend assistance to authors on problems of stratigraphy and nomenclature and to advise the editor and executive committee in regard to the propriety of the use of stratigraphic names and correlations in papers submitted for publication by the Association. The committee shall consist of fifteen members unless a different number is authorized by the executive committee.

Committee on Applications of Geology

SECTION 5. The object of the committee on applications of geology is to advise and promote ways and means for informing the general public on all phases of geology, particularly on the natural occurrence of oil and gas underground, the methods of searching for these substances, and the methods of exploiting them. The committee shall consist of twelve members unless a different number is authorized by the executive committee.

Committee for Publication

SECTION 6. The purpose of the committee for publication is to assist in securing desirable manuscripts for publication in the *Bulletin* or other publications of the Association. The committee may also assist in securing papers for delivery at the annual meetings. The committee shall consist of twenty-four members unless a different number is authorized by the executive committee.

Finance Committee

SECTION 7. The finance committee shall act as financial advisers to the executive committee. The committee shall consist of three members. If a member of the finance committee should be elected to the executive committee he shall resign from the finance committee and the president shall appoint a member of the Association to complete his unexpired term.

Trustees of Revolving Publication Fund

SECTION 8. Before any publication project shall be undertaken with the use of the revolving publication fund the approval of the trustees and the executive committee must be secured. There shall be three trustees. If a trustee should be elected to the executive committee he shall resign as a trustee and the president shall appoint a member of the Association to complete his unexpired term.

Trustees of Research Fund

SECTION 9. Before any research work may be undertaken with the use of money from the research fund, the approval of the trustees and the executive committee shall be secured. There shall be three trustees. If a trustee shall be elected to the executive committee he shall resign as a trustee and the president shall appoint a member of the Association to complete his unexpired term.

Resolutions Committee

SECTION 10. The resolutions committee shall be charged with the duty of presenting at the annual and semi-annual meetings resolutions expressing the Association's appreciation and thanks to those who have worked and contributed to the success of the meetings.

10. It was moved, seconded, and carried that the following change in Article VI of the Constitution be referred to the annual business meeting with the recommendation that the annual business meeting approve it and refer it to the Association.

That the Association shall hold at least one stated meeting each year which shall be the annual meeting. This meeting shall be held in March *or April* at a time and place designated by the Executive committee.

11. It was moved, seconded, and carried that the application of the Illinois Geological Society to become affiliated with the Association be approved and recommended to the annual business meeting.

12. The various methods of handling reprint volumes and symposia suggested by president Barton were discussed and it was voted that it was the sense of the committee that the publication of reprint volumes seems to be the most satisfactory way of handling these symposia.

13. It was moved, seconded, and carried that the committee refer to the incoming executive committee for study the advisability of publishing or republishing the guide-books of field conferences sponsored by local societies.

14. It was moved, seconded, and carried that the incoming executive committee appoint a committee of five to study the advisability of making changes in the Association's method of electing officers and to report to the executive committee before the next annual meeting.

The meeting adjourned at 4:30 P.M.

ED. W. OWEN, *chairman* IRA H. CRAM, *secretary*

EXHIBIT V. REPORT OF COMMITTEE ON GEOLOGIC NAMES AND CORRELATIONS

During the last year, the membership of the committee was increased to seventeen, located at central points throughout the active oil areas of the United States. A meeting of part of the committee was held during the Fall meeting at El Paso, and the annual meeting was at Oklahoma City, March 23, 1939, with eight members and two guests present.

The principal work of the committee is by individual members who check papers submitted for publication in the *Bulletin* and advise the editor whether new and old geologic names are used correctly. Many papers have been checked this year and necessary changes made before publication. Individual members have also answered many questions and given advice in their districts on matters of nomenclature. Last year, the problems of the Lower Cretaceous marine formations of Louisiana and adjacent states was worked out and published in the *Bulletin*. There has been no criticism and it appears that the solution was satisfactory.

This year the problem has been the use of *series* or *subseries* names for the Permian, which now has two divisions in Kansas and Nebraska, three in Oklahoma, several sets of divisions in Texas, and none in the Rocky Mountains. Many geologists now believe that the marine Permian section of west Texas and southeast New Mexico can be divided into at least units that deserve *series* rank, if the Permian itself is a *system*, or *subseries* rank, if the Permian is a *series*. They believe such divisions may be carried long distances to provide one classification for the Permian of the west, if not for the entire United States. Other geologists believe that such a classification will be possible later, but that more work should be done before the divisions are decided upon. This problem was carefully considered in the annual meeting of the committee on geologic names and correlations, and since it was evident that some geologists would very soon submit for publication papers that would suggest new and different series names, the following motion was made and passed.

That the chairman appoint a sub-committee, of members of this committee, including men that know West Texas, to prepare a digest and recommendations for the classification and nomenclature of Permian rocks of the United States; that this sub-committee should invite the collaboration of the Association's research committee and the Permian committee of the National Research Council; and that the report of the sub-committee should be published in the *Bulletin*.

The sub-committee will not be appointed, until the full committee has been appointed and organized for the ensuing year. Its task is a hard one and will need the advice and coöperation of all to secure the best results.

Another subject of discussion has been the naming of subsurface formations. The established rules provide that names of surface formations shall be used wherever possible. However, in some large areas like west Texas and northern Louisiana, some subsurface groups of rocks may never come to the surface or have so radically changed their character, that the extension of surface names to the subsurface has resulted in errors and confusion in the literature. This was considered by the committee, which concluded the matter could be handled without radical changes in the rules, but that all questions of the preference of surface and subsurface formations be referred with recommendations to the authorities involved, and that such recommendations be published in the *Bulletin*. It was recommended that the rules for naming subsurface formations provide that duplicate sets of samples and the electric log (if taken) of the type well be filed with the U. S. Geological Survey and with the Geological Survey of the state in which it is located.

The committee also voted to ask that the Association republish the classification and nomenclature of Rock Units which was published in Vol. 17, No. 7 (July, 1933), since no separates are now available and that particular issue was a small one, it is not sufficiently accessible to the younger members.

The attention of the Association is called to U. S. Geological Survey *Bulletin 896*, a "Lexicon of Geologic Names of the United States" by M. Grace Wilmarth. This complete list fills two thick volumes and makes readily available the type references of all known and accepted geologic names. Authors and members of the committee can now easily determine whether suggested new names have prior use or are available.

JOHN G. BARTRAM, *chairman*

EXHIBIT VI. REPORT OF RESEARCH COMMITTEE

Following is a report of the activities of the research committee during the past year.

Permian volume.—As a result of discussion at the El Paso midyear meeting the research committee has recommended to the executive committee the publication of a special volume of a comprehensive nature dealing with the stratigraphy, sedimentation, and economic geology of the Permian system west of the Mississippi River. It is not anticipated that such a volume would be published within 5 years.

Survey of research opinion.—Post cards and reply cards were sent to each member and associate last December asking them to list in the order of their preference those subjects for research which they thought were of most value and interest to petroleum geology. The results of this survey were published in the March *Bulletin*. It is thought that the results of this survey might well be the basis for considerable future activities. Some of the uses are here enumerated. 1. They might provide a sound basis for a symposium covering

the geology of a large number—possibly fifty or more—of oil fields, described with particular emphasis on the sedimentation, reservoir rocks, and stratigraphy or geologic history involved, these being among the subjects voted as most interesting. The following action was taken by the research committee at its business meeting (March 21).

The research committee recommends that the executive committee authorize the assembling and publication, through the revolving publication fund, of a special volume containing descriptions of 40 or 50 oil fields which are of special interest due to conditions of sedimentation, reservoirs, or stratigraphy. Such a volume would be analogous to the structure symposium volumes. The research committee pledges its support to such a publication and would like to include this as one of its projects to be completed within the next 2 years if possible.

2. The subjects listed were general in character. It is planned to secure specific problems from workers within the general fields, which will be sent to universities and research students everywhere. 3. Separates of the report, as published in the *Bulletin*, are being mailed to 114 university geological departments in the United States, as well as a number in foreign countries, with the compliments of the research committee. 4. Such a survey serves notice on our younger members, particularly our prospective members, of the kind of geology our members believe to be the most important, thus enabling them to prepare themselves to better advantage.

Time of origin and accumulation of petroleum.—The round-table discussion of the research committee which was held during the meeting at New Orleans in March, 1938, was conducted by Ben H. Parker who led the discussion on the time of origin and accumulation of petroleum. This is the research subject upon which F. M. Van Tuyl and Ben H. Parker have been working for the past 3 years and their third annual report follows.

Third Annual Report on the Study of the Time of Origin and Accumulation of Petroleum

The present investigation was undertaken by the writers early in 1937 and through the efforts of Dr. D. C. Barton, then head of the research committee of the A.A.P.G., was sponsored by this group at the annual meeting of the Association at Los Angeles in 1937.

At the New Orleans meeting in March, 1938, the second annual report covering the progress of the study was submitted. Following the research committee dinner some of the essential facts which we had accumulated were presented, and in the discussion which ensued some interesting data bearing on the problem were brought to light.

During the past year twenty-one additional replies to the questionnaires have been received, making a total of one hundred sixteen correspondents who have coöperated out of the twelve hundred geologists to whom queries were addressed.

A large volume of correspondence has developed in connection with information presented by contributors. In some cases the descriptions submitted were considered to be insufficient, while in others additional proof in favor of the line of reasoning followed was desired. As might be expected in a situation of this kind, many personal opinions have been offered without adequate evidence to substantiate them. In those instances where sound supporting facts are not offered the interpretations will not be included in the final report. Until the present time the entire expense of the stenographic service and the postage has been borne by the Colorado School of Mines.

In the early stages of the investigation the more important literature on the geology of oil and gas was reviewed in connection with the preparation of the questionnaire. During the past year several thousand articles, books and reports have been examined in connection with the study. In most instances, no important data bearing on our problem were found. Wherever information of value was encountered it was abstracted.

Attention so far has been directed almost entirely to contributions in the English language, though numerous reviews and abstracts of articles and reports in other languages have been read. Prior to the completion of the report it is hoped that arrangements can be made for the translation of the more important sections of foreign contributions which may have a bearing on the problem. As Dr. Barton has suggested, considerable time and money can be saved by requesting leading foreign workers to submit lists of worth-while articles for investigation. Letters seeking such information have already been forwarded. By employing this procedure it is believed that a substantial portion of the two hundred dollars ($200.00) set aside by the research committee for this purpose may be saved.

All the data so far compiled from the questionnaires, the literature and private correspondence, have been copied, catalogued and filed. It is estimated these data involve more than one million words. From this accumulated material the final report which will incorporate subject matter equivalent to between 100 and 200 A.A.P.G. *Bulletin* pages will be prepared. The acceptance or rejection of any or all of this material for publication will rest with the Association.

As a result of the recent grant by the research committee of one hundred dollars ($100.00) for stenographic service the completion of the manuscript by September 1, 1939, the time set in our previous report, is assured.

F. M. VAN TUYL
BEN H. PARKER

Golden, Colorado,
March 15, 1939

Education work.—The recent rapid growth of our Association and the large number of geology students everywhere who anticipate entering the field of petroleum geology makes it seem to us that some group within the Association should take a particular interest in these younger men. While such an activity might not be strictly within the province of the research committee, your chairman has busied himself with work of this kind and wishes to make a report of it here.

There apparently is a desire on the part of geological departments in a number of universities to have speakers from among our older and more experienced members. Ordinarily there is no fee available for such work, but the expenses would be paid for those who would be willing to give one or more lectures to the students. It is my thought that someone could act as a clearing-house where those members willing to give lectures would be put in contact with those schools desirous of having them. As a result of a very small amount of work some twenty lectures by our members were given at various universities located in the central states the past winter. The universities in the oil producing areas have in the past generally availed themselves of members who would lecture on petroleum geology, but many of the universities outside the oil producing areas would apparently greatly appreciate the opportunity to have such lectures presented to their students. This seems to be a service which would be mutally beneficial and worth while developing.

It is planned to make a survey of the number of students in the various universities who are graduating as majors and who are working toward advanced degrees in geology. Such a survey, coupled with a percentage of the graduates who enter petroleum geology and published each year, it seems would do two things: first, it would furnish statistics which would focus our attention on the number of students contemplating petroleum geology as a life work in order that we might take suitable measures to provide for them; second, it would furnish the student of geology statistics on which he might better gauge the field of petroleum geology and have some idea of the competition with which he will be faced upon graduation.

These two activities have been started and in the event that they should develop they might later be consolidated into a special committee dealing with matters of education and composed of a small group of members who are interested in the subject. In addition, such a committee might well act as a clearing-house for college curricula, and similar data.

Research in universities.—Members of the research committee, either directly or indirectly, have surveyed the research now going on in approximately twenty or twenty-five university geological departments which might be of value or interest to petroleum geologists. The result is that, in so far as these universities are concerned at least, we have been unable to find any research worthy of reporting. We feel that this is an unhealthy situation. It probably can be remedied by the research committee and the membership in the Association at large taking a more active interest in the work that is going on in the various university geological departments. In almost every case these departments were interested in discussing the problem and in learning of projects which would be of interest to petroleum geologists. The contact of the professors, however, with petroleum geology was generally not recent and they were, therefore, rather hesitant to advise their students as to research projects that would be of particular value to petroleum geology. Our purpose in questioning the various geological departments was to locate, if possible, fundamental research now going on in which we might assist and encourage; and while we have by no means covered the field, yet we feel that if it were covered we would find that there is probably a negligible amount now in progress. It is hoped that the survey of opinion among our membership as to desirable lines of research will eventually stimulate more work which will be of interest to us.

Research fund.—The research committee at its business meeting (March 21) made the following recommendation to the executive committee.

That an amount of money up to $1,000 be appropriated annually from the general fund of the Association to assist in the completion of worthy research projects in petroleum geology—and such projects to have the approval of the research committee and the results to be available for publication in the *Bulletin*.

Samples from floor of Gulf of Mexico.—The Houston Geological Society together with the paleontological departments of some twelve oil companies operating in the Houston area have asked that the Association research committee lend our support in attempting to secure the aid of the United States Coast and Geodetic Survey to the end that systematic samples from the floor of the Gulf of Mexico be made available for study. It is understood that the Coast and Geodetic Survey have a boat operating in the areas from which samples are desired and that it probably would not require much extra work on their part to secure them.

The following resolution was adopted by the research committee.

Whereas, the proposal of the Houston Geological Society to secure samples from the floor of the Gulf of Mexico through the assistance of the U. S. Coast and Geodetic survey is one of wide interest and importance to petroleum geologists,

We therefore strongly recommend the official approval of the Association be given this project.

Houston Geological Society study groups.—One of the interesting activities to be noted is the organization of some fifteen study groups by the Houston Geological Society under the leadership of Perry Olcott. Various topics are studied by groups of five to fifteen members at weekly meetings, and the re-

sults are being written up for use of the Society and possible publication. As one topic is completed by a group the members dissolve and join other groups, depending upon their interest, with the result that any person might develop an understanding of four or five fields during the year. Some of the topics are: sedimentation, stratigraphy, paleogeography, aerial geology, geophysics, structural geology, electrical well surveying, valuation, mechanical well surveying, and economics.

Bass-Neumann research project.—A group of three geologists and three chemists under the chairmanship of L. M. Neumann have been investigating the relation of crude oils to stratigraphic occurrence. Considerable progress has been made and some results of fundamental importance to petroleum geology are in sight. A partial report of the results to date will be made at one of the technical sessions of this meeting. This committee is an outgrowth of research work started several years ago by the Tulsa Geological Society and has now developed to the point that it is of wide interest to petroleum geologists everywhere, and the research committee at its business meeting (March 21) recommended to the executive committee the appropriation of $750. for chemical analyses of oils by the Bureau of Mines chemists from accurately located reservoirs in Oklahoma and Kansas in order satisfactorily to complete the project, and money to come from the research fund.

A. I. LEVORSEN, *chairman*

EXHIBIT VII. REPORT OF COMMITTEE ON APPLICATIONS OF GEOLOGY

This report, the seventh, of the committee on applications of geology, outlines the activities and efforts of the committee and other geologists to educate the general public in the usefulness and practical application of geology to everyday life. Some progress was made but the accomplishments appear small in comparison with what might be done if more geologists could be interested in bringing geology to the people. Similar progress reports have been published in the May *Bulletin* for the past 6 years. Thanks are given all members of this committee and all other geologists for their efforts in publicizing geology. It is hoped that future committees will take a keen interest in this work.

The following is an outline of the reports of committee members for the past year.

Pacific Coast.—The activities of the Pacific Coast Section were reported by E. K. Soper. Several articles written in semi-popular style, dealing with landslides, earthquakes, fossils, *et cetera*, prepared by members of the Section, were published in the Sunday magazine section of a leading Los Angeles newspaper. U. S. Grant gave several public lectures under the auspices of the University of California at Los Angeles, describing geologic processes that influence or control conspicuous changes which have recently taken place in the physical aspects of certain Southern California beaches.

No exhibits were sponsored by the Section, especially since excellent exhibits, prepared by the State, are now on display at the Golden Gate International Exposition on "Treasure Island" in San Francisco.

The teaching of geology in Los Angeles high schools is increasing. This work was originally begun largely through the efforts and coöperation of members of the local committee on applications of geology.

South Texas.—I. O. Brown of San Antonio reported the activities of Association members in South Texas. Geologists there cooperated in the interest of public health and welfare on such problems as community water supplies in the Edwards Plateau, where water for domestic use is obtained from cavernous limestone. The problem is the prevention of contamination from shallow sewage disposal.

Association members published articles and gave talks before civic clubs, dealing with the application of geology to the problems of the petroleum industry. Such articles as that by W. Armstrong Price, "Influence of the Physical Environments on the Colonization of Texas," indicates to the public that geology and its processes do have a definite influence on everyday life.

The Society library and museum in the Milam Building, San Antonio, enjoy steady growth in value and popularity. Improvements continued in the re-arrangement of literature and cataloging of specimens under the supervision of Felix A. Vogel, Jr., and his committee. The Society accepted valuable volumes and purchased the 18th and 21st United States Geological Survey annual reports.

Texas-Louisiana Gulf Coast.—Olin G. Bell reported the activities of the Houston Geological Society and the South Louisiana Geological Society.

The Houston Society held several meetings in the Houston Public Library to which the public was especially invited. These dealt with the field of geology such as water resources, erosion, conservation problems, *et cetera*, in public parks, both State and National. Likewise several talks were given by some of the members at the University of Houston and Y. M. C. A. night schools. This Society is sponsoring a geological library in the Houston Public Library.

The members of the South Louisiana Geological Society held several meetings open to the public, when the subject under discussion was one of appealing interest. Speakers also discussed geologic problems at luncheon clubs, Chamber of Commerce meetings, Boy Scout meetings, *et cetera*.

Central Texas.—Hal P. Bybee, of the University of Texas, participated in the vocational guidance programs of the Kiwanis Club, at which he explained the value of geology. One of the most worth-while activities that Bybee participated in was his work with the Boy Scouts. He has taken a keen interest in bringing geology to the Scouts and advises he will continue his efforts. He sponsored the booth on geology at the Annual Merit Badge Show of the Capital Area Scout Council. This show was visited by several thousand people. He also gave talks to other organizations relative to geology as a cultural subject.

Middle West.—Carey Croneis of the University of Chicago was active in promoting a geologic consciousness to the general public. He delivers 20 or more geological lectures each year to the junior colleges in the Chicago area. These and similar lectures by J Harlen Bretz of the University of Chicago and John R. Ball of Northwestern University are considered of prime importance for these schools have large enrollments and no definite geologic courses. Other important lectures given by Croneis during the past year were to the Engineers Club of Fort Wayne, Indiana, and to Knox College and the Illinois State Museum. Total attendance at these three lectures was considerable over 3,000 persons, approximately 2,000 being in attendance at Fort Wayne. From the response to these lectures and from

correspondence concerning them, it is apparent that there is an awakening public consciousness regarding the science of geology.

Missouri.—H. S. McQueen, of the Missouri Geological Survey, contributes evidence that the Survey continues to serve well the people of that state and continues to more thoroughly create in the public mind the practical application of geology to the problems of everyday life and living. The nature of the Survey's work and its contacts, both personal and through the press and its own publications, promotes the practical application of geology to the uses and benefits of the public.

The ambitious oil lease play in Northern Missouri the past year, materially increased the already voluminous requests of the Survey for geological information. The Survey has endeavored above all else, to keep uppermost in the minds of operators and the public, the necessity for first class geological work prior to the drilling of test wells for oil and gas.

The Missouri Survey continued its annual program of excellent service in the development of sanitary water supplies from deep wells, which promotes interest in its work and materially increases its files on drill cuttings from all such wells drilled. The educational program in connection with the State Board of Health has borne fruit as attested by the increasing number of requests from individuals who are interested in an uncontaminated supply of water from deep wells. Members of the Survey staff prepared articles of general news interest for publication in the metropolitan papers of the state. Talks on general geology and the mineral resources of the state were given before schools and other organizations. Similar talks were made by members of the educational institutions of the state and news items on general geology emanated from the geological departments of these institutions.

The Survey continues to maintain a mineral exhibit at the State Fair and the State exhibits at the San Francisco and the New York fairs will have extensive space devoted to the geology and mineral resources of Missouri. The State geologist has served as a member of both World's Fair commissions.

Shreveport district.—C. R. McKnight, of Shreveport, teaches classes in general geology at Centenary College night school. The object of these classes is to acquaint students with the general meaning of geology and its processes as applied to the petroleum industry. One year of general geology and one year of petroleum geology is offered. The majority of students in these classes are men employed in some capacity in the oil industry who have no other opportunity to obtain the information taught in this night school. The class work, together with outside discussion and related press notices, helped considerably to create a better understanding and appreciation of geology in drilling wells for oil and gas in this area, which includes North Louisiana, East Texas, and South Arkansas. The greater part of the students were eager to learn the fundamental basis of geology and its use, and some of the students traveled as much as 300 miles in one evening to attend the classes.

Rocky Mountain district.—A. E. Brainerd of Denver reports that members of the Association gave talks on various phases of geology before many of the clubs in Denver, in Colorado Springs and in Casper. At least a dozen such talks were given by four or five members of the Association.

The Rocky Mountain Association of Petroleum Geologists holds meetings every two weeks from October to April, inclusive, at which meetings talks on

varied phases of geology are given. These meetings are open to the interested public and have been well attended by non-members of the Association. One meeting each year is held at the University of Colorado, one at the Colorado School of Mines, and now Colorado College in Colorado Springs will be added.

During the first week in September, 1938, the Kansas Geological Society and the Rocky Mountain Association of Petroleum Geologists held a field conference along the Front Range from Beulah, which is south of Canon City, to Fort Collins. This conference ended in Estes Park. The trip was given considerable publicity in various Colorado papers, which helped materially in bringing geology before the public.

During the past year, Brainerd talked several times with A. J. Stoddard, Superintendent of Schools in Denver, with passing mention of geology. He outlined for him, many geological features of interest for a trip which Stoddard made to California. This was not only appreciated but will be helpful in bringing geology into the public schools. Geology is now an elective science in Denver high schools. It is of interest that Stoddard goes to Philadelphia next fall as head of schools there.

Keen public interest in geology is apparent in Colorado. Each year the meeting of the Metal Mining Congress is held in Denver, with noted speakers from all over the country attending. These talks and these meetings are brought before the people by the Press. Denver has an active chapter of the A. I. M. E. and an active engineering chapter in which mining engineering and irrigation are the most important problems. Both of these societies have geology as one of their major interests.

National Parks.—The following brief digest of the work of the National Park Service in publicizing geology was supplied by Earl A. Trager, chief naturalist.

The Park Service employs geologists not only to aid in the development of parks but also to interpret the geological features for the visitors. One of the chief activities of the geological staff is the educational program which includes lectures around camp fires, on hiking trips, on guided trips by horseback, by boat, by auto caravan and by the planning and the preparation of exhibits in museums and along trailways. Since geological features are of outstanding importance in many of the national parks, the educational contacts made by the naturalist's staff brought the geology of the parks to over four million people or about 70 per cent of those who visited the national parks during the past year.

Another means of bringing the geological story of the parks to the general public is through press releases available to all newspapers and through informative circulars distributed to visitors in the parks. All of these feature articles are critically reviewed by the Park naturalists, the regional geologists and finally by geologists in the Park Service in Washington. Lectures are also given outside of the park areas by geologists and other members of the Naturalist Division.

A popular and effective medium for disseminating geological information in the parks is the park museums, of which a considerable number have already been built. These museums contain exhibits telling the story of the geology of the parks. The exhibits consist of maps, diagrams, carefully worded texts, relief models, dioramas and specimens arranged to present a popular unified story of the geology. One of the outstanding geological exhibits is now being installed at Yosemite and will be housed in eight large cases.

The museum displays are augmented by signs and structure exhibits erected along trails, which exhibits explain in simple terms, unusual topographic features, the origin of some rock type, the name and significance of fossil deposits in place, *et cetera*.

To further emphasize the importance of the educational program of the Park Service, in publicizing geology, the permanent naturalist staff during 1938 totalled 33, of which 14 are trained geologists, spending at least a part of their time in teaching geology to the public in the most practical way, namely, in the field to millions of people. During the travel season, this force was augmented by 93 temporary ranger-naturalists, of whom 20 had some geological training.

The National Park Service has enjoyed the cooperation of many geologists of high standing outside its own ranks. Joint projects with other organizations enabled Francois Matthes of the United States Geological Survey to conduct two years' research in Yosemite and Sequoia, results of which work will be made available to the public by some appropriate popular means. Arthur Keith, retired from the United States Geological Survey, is to prepare a popular report on the geology of the Great Smoky Mountains. W. E. Aldin has prepared a popular account of the geology of Glacier National Park. H. E. Gregory of the United States Geological Survey has just completed a manuscript on the geology of Zion and Bryce Canyon national parks. Howell Williams of the University of California is pursuing studies relative to the origin of Crater Lake. R. W. Wilson, California Institute of Technology, will undertake paleontologic research at Boulder Dam Recreational Area.

The past year a research fund of $1,000 was set up and will be used to defray field expenses of projects similar to those just outlined.

The more important geologic reports which have been completed this year for distribution to the public are listed below.

H. E. Gregory:
Geologic Sketch of Zion National Park (in manuscript)
Geologic-Geographic Sketch of Bryce Canyon National Park (in manuscript)
F. E. Matthes:
Three volumes of geologic photographs with explanatory texts representing the outstanding features of Yosemite and Sequoia National Parks, prepared for use in the museums of these parks
F. C. Potter:
The Origin of the White Sands at White Sands National Monument (in manuscript)
Lecture on Volcanism: A prepared text accompanied by colored lantern slides which is distributed to organizations which have use for such a lecture
E. A. Trager and F. C. Potter:
Geologic Report on Cape Hatteras National Seashore
Thos. J. Graham:
The Florida Caverns at Marianna, Florida
Robert H. Griffin:
A Geologic Cross Section of the Great Smoky Mountains National Park (in manuscript)
L. Bryant Mather, Jr.:
A report on the Geology of Patapsco State Park, Maryland, published by the Natural History Society of Maryland, as Proceeding No. 5
C. Frank Brockman:
Recession of Glaciers in Mount Ranier National Park, Washington, July-August, 1938
Howard K. Stagner:
Geologic Notes on Petrified Forest National Monument (mimeographed)

Ross A. Maxwell:
Geological Report on Big Bend National Park (Proposed Brewster County, Texas) (in preparation)
B. F. Moomaw, Jr.:
The Rocks and Minerals of the Kilauea-Mauna Loa Section, Hawaii National Park, Natural History Bulletin No. 3
E. T. Schenk:
Preliminary Report on the Geology of Boulder Dam Recreational Area

Mid-Continent.—Robert H. Dott, director of the Oklahoma Geological Survey, continued his efforts to create in the minds of the general public, the practical application of geology. Obviously much of his work is devoted to that end in disseminating, as widely as possible, particularly by correspondence and public addresses, correct ideas as to the occurrence, origin and relation of rocks, minerals ores, and water supplies.

In December, 1937, he addressed the annual meeting of the American Railway Development Association on, "Geological Surveys," pointing out how members of the Railway Association may use geological surveys and geologists in locating new mineral industries along their railway systems.

The Survey staff is writing a series of articles for the Oklahoma City Chamber of Commerce magazine, *Oklahoma*, on the work of the survey and the State's mineral possibilities.

The November, 1938 issue of the magazine, *Better Roads*, carried an article, with two pictures, on the geological highway markers in the Arbuckle Mountains.

The survey supplied information to the *Keystone Coal Buyers Manual*, published by McGraw-Hill, regarding Oklahoma coal fields.

The Tulsa Geological Society has been active in publicizing geology through its technical meetings held twice a month from October to May, inclusive. These meetings are open to the public by invitation through the press and are frequently attended by large numbers of non-members. It also frequently has at its weekly luncheons through the year, geological discussions of popular interest, to which non-members are invited and frequently attend. Several members have also talked at luncheons of the civic clubs such as Rotary, Kiwanis, and Chamber of Commerce on geology and geophysical subjects of popular interest.

Other activities by members of the Association are worthy of mention. This consists of a series of lectures at leading universities on specific phases of petroleum geology by such practical and able men as Ira H. Cram, A. I. Levorsen, Alex W. McCoy, and perhaps others. These lectures were primarily for senior students in geology and graduate students.

Your chairman was a member of Gustav Egloff's committee, which supervised and planned the installation of a magnificent geological, geophysical and petroleum industry exhibit in the Hall of Science at the International Petroleum Exposition held in Tulsa in May, 1938. Many of these exhibits were previously shown at the Century of Progress in Chicago in 1933 and are now permanently housed in the Museum of Science and Industry in Chicago. In addition to the Chicago exhibits, 50 other contributors were represented.

These exhibits were too numerous to discuss in detail in this report and word descriptions are inadequate but some of the outstanding ones should be mentioned. The general theme of all of these exhibits was geology, geophysics, drilling, production, pipe lines, refining, and the products of refined petroleum.

The geological exhibits were mainly shown by block models or by appropriate charts. One large model illustrated a simple anticline, showing surface structure by appropriate outcrops and the subsurface structure in cross section. A typical "buried hill" structure in block model, of the Billings field in Oklahoma, showed the pre-Pennsylvanian topography and areal geology. Another model of the Oklahoma City field illustrated the same features and also the fault scarp along the east side. Another model of the Fitts field exhibited the surface topography with the surface equipment and below in cross section the subsurface structure and the various oil producing reservoirs. The salt dome structural type was exhibited in block model of Barbers Hill, Texas, showing the overhanging salt mass and the upturned oil sands around the edges of the salt plug. Drawings exhibited the simple oil traps such as anticlines, faults, and stratigraphic traps.

The geophysical prospecting methods were illustrated by electrified models, showing the positions of the shot point and the seismometers. The path of the sound wave from shot point to seismometer was traced by traveling electric lights indicating the relative speed of the sound as it passed through rock formations of different density. Other electrified models illustrated the operation of the magnetometer and pendulum in mapping buried granite peaks or ridges and arching limestone beds.

Charts and models exhibited directional drilling, crooked holes and their causes, and explanations as to how to control directional drilling. Drilling muds were discussed and samples of various muds were shown in glass containers.

Operating models showing pumping wells, in which glass tubes represented casing through which the pump plunger and the circulating oil could be seen, were displayed. The arching oil reservoir beds were shown at the bottom into which the miniature oil wells entered. The University of Kansas exhibited an animated model illustrating the acidization of limestone reservoirs with a synchronized sound record, explaining the process. Water flooding was illustrated by a working model showing the water entering the reservoir, its passage through it and the advancing oil column ahead of the flood.

One of the dioramas illustrated the various phases of pipe line operations, including the ditching, welding, and filling machines.

Refining was illustrated by several miniature but complete gasoline plants and a complete refinery in active operation showing the various phases of oil refining and the products separated at each stage.

Another interesting and educational exhibit was the petroleum tree, showing samples in bottles and jars of the many oils, petroleum jellies, waxes and other by-products obtained and made from crude oil.

The Hall of Science was one of the most popular places of the Exposition. It was estimated that during the week of the Exposition, at least 250,000 visitors passed through the Hall of Science. Guides were in attendance at all times and were kept busy explaining the exhibits and their significance.

Your chairman attended a general press conference at the A. P. I. meeting in Chicago, in November, 1938. The field of geology was reviewed, together with the various geological tools, which have been used with varying success. The rapid progress in applying geology to industry was mentioned and it was pointed out that the benefits to industry have been passed on to the public in more and better products at less cost. As a result of the publicity given

this interview, numerous letters were received from people in various walks of life and many places, asking further questions about the articles they had seen published.

Your chairman gave a 30-minute talk at the Rotary Club luncheon in Oklahoma City on March 21, 1939, on "Geology and Its Service to the Public." He outlined the general field of geology and its processes, the many and varied applications of geology to industry and public welfare and some of its purely cultural aspects that could be enjoyed by all people that would make the effort to investigate. He made a plea for coöperation in bringing geology to the younger people by having geology taught in all public schools.

FRANK R. CLARK, *chairman*

EXHIBIT VIII. REPORT OF COMMITTEE FOR PUBLICATION

The committee for publication, consisting of 23 members, has functioned reasonably well during the past year, from March, 1938, to March, 1939. Some members have been particularly active; others have had less time available; but in any case, directly or indirectly, I believe that the work of the committee has been of value to our editor in soliciting manuscripts for the *Bulletin*. In the course of the year some 45 papers were written largely as a result of encouragement of authors by this committee.

The main duty of this committee, it should be remembered, is to be on the lookout for subjects for *Bulletin* papers, to seek authors for worth-while subjects, and to follow up suggestions with encouragement to such authors. In no way does this committee assume any responsibility for editing. This responsibility belongs solely to the editor of the Association and to his helpers, the associate editors.

During the year I have urged soliciting brief papers for the column "Geological Notes," stating the location, the geological structure, and the technical reason for drilling, of recently discovered pools. A large percentage of wildcat wells are located and drilled for geological or geophysical reasons. They are a record of exploration guided in the main by technical advice. Consequently, the discovery of oil or gas must be of especial interest to us geologists, and no better place could be found for recording the early history of each important new discovery than in our own *Bulletin*. I hope this type of contribution will be vigorously sought and encouraged in the future.

Among suggestions offered by several committee members were the following.

1. With reference to notes on new fields, that the nomenclature committee, responsible for naming such fields in each district, be requested to inform the editor of each new discovery, giving him the name of the man most suitable for writing a description of the discovery.

2. That a regular editorial column be established in the *Bulletin* for the expression of personal ideas on topics selected by members who would be invited by the editor to write such contributions.

3. That an effort be made, possibly by the editorial staff, to encourage selected members to bring up to date, for *Bulletin* publication, knowledge of important fields or regions, on which articles were printed years ago in our publications—fields and regions where, as a result of drilling, we now have a greatly increased body of information.

4. That the Association appoint and finance a traveling contributor to the *Bulletin*, a man who would gather interesting data in the various centers of our activity, and who would put such information into readable form.

5. That, as the personnel of this committee changes from year to year, new appointees be selected as far as practical from among our younger Association members.

I have merely listed these suggestions, but all of them deserve consideration.

In closing, I may add that the need for aggressive efforts by this committee still remains, and may continue indefinitely. In spite of the good work accomplished and in spite of the several meetings providing material for papers during the year, the editor states that there are now on hand only enough articles to take care of the *Bulletin* through May. Although the Oklahoma City program will yield enough additional material to last through November or December, we shall have to encourage the writing of papers for the succeeding 5 or 6 months in 1940. Observe that the first three suggestions listed above would provide considerable new material.

FREDERIC H. LAHEE, *chairman*

EXHIBIT IX. REPORT OF REPRESENTATIVE TO NATIONAL RESEARCH COUNCIL

Herewith I submit for your approval my report as representative of the Association on the Division of Geology and Geography of the National Research Council. The Division held its annual meeting on April 30, 1938, in Washington, D. C. As in previous years, summaries of the work accomplished during the year by the various committees of the Division were presented for discussion. I shall briefly review those which seem to be of most interest to our members.

Dr. Parker D. Trask, chairman of the *Committee on Sedimentation*, reported satisfactory progress in the preparation of a symposium on recent sediments. I am glad to add that this work was brought to completion and that, through arrangements with our editorial staff, the results will soon be printed by the Association as a volume entitled *Recent Marine Sediments*. This book will be ready for distribution next fall. The committee on sedimentation prepares bibliographies on different fields of sedimentation. It has completed a list of unpublished theses on sedimentation, written by advanced students in various American colleges and universities. These bibliographies and lists may be obtained from the secretary of the Division at Washington.

The *Committee on Stratigraphy*, with Carl O. Dunbar as chairman, has been active for over five years compiling formation or correlation charts of North America. Each member leads a subcommittee on a major group. Mr. H. D. Miser, in discussion, brought out the fact that this committee's charts will not conflict with, or duplicate, those which are being made under Miss Wilmarth's direction for the U. S. Geological Survey.

Dr. C. R. Longwell reported continued accumulation of data by the *Committee on Tectonics* for the tectonic map of the United States. In order that this map may show the structural features of the country as nearly as possible in accord with the latest interpretations of geology, copies of the finished sections of the map are to be sent to individuals and institutions for final corrections and additions. It is largely for this purpose that Mr. Levorsen

has designated this tectonic map of the United States as the major theme for discussion at our research committee meeting on March 21.

Little progress could be reported for the *Committee on Conservation of the Scientific Results of Drilling*. The former chairman, Professor Allen C. Tester, resigned and in his place Professor W. H. Twenhofel was appointed. Dr. Twenhofel selected a subcommittee of three (Thom, Sellards, and Lahee) to make a questionnaire investigation of what has been, and is being, accomplished by State geological surveys throughout the country to secure and preserve for study the samples of geological formations obtained in drilling wells. Replies to the questionnaire are now coming in. They will be reported at the meeting of the Division next month.

The *Committee on Research in the Earth Sciences* has two sections, one geologic and the other geographic. The geologic section has two sub-committees. One of these, under the chairmanship of A. I. Levorsen, was chosen to investigate desirable lines of research in petroleum geology. Toward this end Mr. Levorsen circulated the membership of the Association with a post card questionnaire. He will summarize the 1,200 replies which he received and will report to the Division in April.

For those who may be interested I am listing below the names of our Association members who are also members of the several committees mentioned above.

Committee on Sedimentation: E. Blackwelder, M. N. Bramlette, M. M. Leighton, H. B. Milner, R. Dana Russell, F. P. Shepard, W. A. Tarr, Allen C. Tester, Parker D. Trask, A. C. Trowbridge, W. H. Twenhofel, T. Wayland Vaughan.

Committee on Stratigraphy: Raymond C. Moore, John B. Reeside, Jr., L. W. Stephenson, W. H. Twenhofel, C. E. Weaver.

Committee on Tectonics: C. H. Behre, Jr., A. I. Levorsen, T. S. Lovering, W. H. Monroe, Ralph D. Reed, W. T. Thom, Jr., A. C. Waters.

Committee on Conservation of the Scientific Results of Drilling: Marcus A. Hanna, F. H. Lahee, H. S. McQueen, E. H. Sellards, W. T. Thom, Jr., W. H. Twenhofel.

Committee on Research in the Earth Sciences: A. I. Levorsen, T. S. Lovering, T. Wayland Vaughan.

FREDERIC H. LAHEE, *representative*

EXHIBIT X. REPORT OF RESOLUTIONS COMMITTEE

BE IT RESOLVED, That we, the members of the American Association of Petroleum Geologists, express our appreciation and our sincere thanks to the Oklahoma City Geological Society, the Shawnee Geological Society, the Ardmore Geological Society, and to all of those who have worked and contributed to the success of our 24th annual meeting in Oklahoma City and, particularly, to the following.

R. W. Laughlin, general chairman, J. T. Richards, chairman in charge of technical program, John E. Van Dall, chairman in charge of arrangements, and all other chairmen and members of committees.

The Oklahoma City Chamber of Commerce and its able staff.

Honorable Reford Bond, chairman, Corporation Commission of Oklahoma, Oklahoma City.

The many oil, industrial, and supply companies for their generous contributions of time and assistance, and the exhibitors for their excellent displays.

The Oklahoma City press and the national trade journals for the high standard of publicity covering this meeting.

The Skirvin Hotel management and, particularly, Mr. W. B. Skirvin for the excellent service provided and the generous cooperation in placing at our disposal the facilities for the conduct of our meetings.

BE IT FURTHER RESOLVED, That the sincere thanks of the Association be given to the executive committee and to Mr. J. P. D. Hull and his headquarters staff for the able and successful manner in which they have conducted the affairs of the Association during the past year.

BE IT FURTHER RESOLVED, That these resolutions be included in the minutes of the meeting and copies be sent to the individuals and organizations named.

FRANK A. MORGAN, *chairman*
C. L. MOODY
EDWARD A. KOESTER

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 23, NO. 5 (MAY, 1939), P. 757

RESEARCH NOTES

ANNOUNCEMENT

The research committee is pleased to announce that the executive committee of the Association has set aside for its use during the coming year the sum of $1,000 for the purpose of *aiding in the completion of research projects* which are of particular interest to petroleum geology. Grants will be made from the research fund upon the recommendation of the research committee and the approval of the executive committee and the trustees of the research fund. It is stipulated in the grant from the executive committee that the description of the results of any research project to which aid is given shall be available for publication in the *Bulletin* of the Association.

The research committee will give first consideration to projects of a fundamental and wide interest to petroleum geology and projects which have been started and progressed to the point where results of value are assured.

Correspondence from an applicant should include a complete description of his project, a statement of the progress which he has made, and a discussion of the relation that the expected results will have to petroleum geology.

A. I. LEVORSEN, *chairman*, research committee

RESEARCH PROBLEMS

The survey of research opinion among our membership as published in the March *Bulletin* showed the major interest to be in the related fields of sedimentation, reservoir conditions, stratigraphy, geologic history, porosity and permeability. Anyone with ideas as to desirable specific problems within these general fields is requested to communicate with the research committee. It is hoped that a group of such problems may be outlined and published in the *Bulletin* and also distributed to the various college geological departments where candidates for advanced degrees may give them consideration.

It is suggested in submitting individual problems suitable for research that a brief statement be given as to the need for and the relation of the problem to petroleum geology. Any suggestions as to technique, methods of attack, or other persons who would be in a position to aid in the research would be helpful to the prospective research worker and should be included.

A. I. LEVORSEN, *chairman*, research committee

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 23, NO. 5 (MAY, 1939), PP. 758-764

AT HOME AND ABROAD

CURRENT NEWS AND PERSONAL ITEMS OF THE PROFESSION

The Alberta Society of Petroleum Geologists, Calgary, Canada, has elected new officers as follows: president, HARRY M. HUNTER, Canadian Western Natural Gas, Light, Heat, and Power Company, Ltd.; vice-president HARRY THORNE, C. and E. Corporation; business manager, D. MACKENZIE, Turner Valley; and secretary-treasurer, R. G. PATERSON, Canadian Western Natural Gas, Light, Heat, and Power Company, Ltd., 215 Sixth Avenue West, Calgary.

DORSEY HAGER, consulting geologist of Centralia, Illinois, talked before the St. Louis Section of the A.I.M.E. on "The Evaluation of Oil Developments in Illinois, Northern Missouri, and Southern Iowa."

The preliminary program of the spring meeting of the Eastern District of the American Petroleum Institute's Division of Production at Pittsburgh, April 4–5, included the following: PAUL H. PRICE, State geologist of West Virginia, "Oriskany Sand Development in West Virginia and Oil and Gas Possibilities in It and Deeper Horizons"; HAROLD MCCLURE, president, Michigan Oil and Gas Association, "Recent Developments in the Oil and Gas Industry in Michigan"; THERON WASSON, chief geologist, Pure Oil Company, "Progress Report on Developments in Southern Illinois and Adjacent Territory in Western Kentucky and Indiana"; H. M. BAKER, United Fuel Company, "Dehydration of Natural Gas"; JOHN CLARKE, Hope Natural Gas Company, "High-Pressure Gas Transmission"; P. E. FITZGERALD, geologist, Dowell, Inc., "Improvements to Chemical Treatments of Oil and Gas Wells"; RALPH E. DAMP, Carter Oil Company, "Review of Illinois Basin Operating Problems"; JOHN A. THOMPSON, Belmont Quadrangle Drilling Corporation, "Modern Methods Applied to Cleaning Out and Drilling Deeper"; J. S. PIGOTT and P. G. EXLINE, Gulf Research and Development Company, "Oil and Bearings"; HARRY M. RYDER, Ryder-Scott Oil Producers, "Production Flooding Efficiency"; SYLVAIN PIRSON, Pennsylvania State College, "Critical Review of the Geochemical Methods of Prospecting for Oil and Gas."

E. A. RITTER has been transferred from Colombia to Holland. His new address is Carel van Bylandt Laan 30, den Haag, Holland.

ARNOLD S. BUNTE, formerly subsurface engineer with the Shell Petroleum Corporation in Kansas, is now associated with Harvey Heller, Kennedy Building, Tulsa, Oklahoma, in the capacity of geological consultant.

ALFRED H. BELL, of the State Geological Survey of Illinois, spoke before the Southwestern Geological Society at the March meeting in Austin, Texas. His subject was "The Oil and Gas Industry of Illinois." SAMUEL S. GOLDICH, of the Agricultural and Mechanical College of Texas, was the speaker at the February meeting and his subject was "Some Problems of Rock Weathering."

ALFRED C. LANE, chairman of the National Research Council Committee on Determination of Geologic Age, spoke on the subject "Does Mother Earth Show Her Age?" before a joint meeting of the Tulsa Geological Society and the Mid-Continent Section of the A.I.M.E., at Kendall Hall, University of Tulsa, March 27.

WALTER B. JONES is director of the Department of Conservation, at Montgomery, Alabama.

The Appalachian Geological Society held a symposium on deep sands, March 13, at the Hotel Morgan, Morgantown, West Virginia. PAUL H. PRICE, State geologist, presided at the dinner. ROBERT C. LAFFERTY, of Owens, Libbey-Owens Gas Department, is president of the society. The discussion on deep sands was led by M. GORDON GULLEY, of the Gulf Oil Corporation, Pittsburgh, vice-president in charge of the northern division of the society. The speakers included QUENTIN L. WILCOX, of the Carnegie Natural Gas Company, Pittsburgh; RAY V. HENNEN, consulting geologist of Morgantown; A. Y. BARNEY, of the Columbian Carbon Company, Charleston; H. R. BRANKSTONE, of the Gulf Oil Corporation, Pittsburgh; and J. H. C. MARTENS, of the University of West Virginia and the West Virginia Geological Society.

PAUL F. OSBORNE, of the Tide Water Associated Oil Company, has moved from Mattoon, Illinois, to Evansville, Indiana.

G. A. V. STANLEY, formerly with Oil Search, Ltd., Sydney, Australia, has been transferred to the Australasian Petroleum Company Pty., Ltd. After leave in Australia, he will return to New Guinea in June.

IVAN J. FENN is with Subterrex at Houston, Texas.

A. M. LLOYD, of the Sun Oil Company, Shreveport, Louisiana, presented a paper at the March 14 meeting of the South Louisiana Geological Society, at Lake Charles. His subject was "The Surface Beds Outcropping in Southern Sabine, Vernon and Rapides Parishes, Louisiana."

The Geological Society of America is presenting the following addresses on the theme, "Frontiers of Geology," through the courtesy of the Educational Division of the National Broadcasting Company: April 24, at 7:30–7:45, Eastern Standard Time, "Submarine Canyons," by PAUL A. SMITH, United States Coast and Geodetic Survey; May 1, at 7:30–7:45, Eastern Daylight Time, "Shifting Ocean Levels," by DOUGLAS W. JOHNSON, Columbia University, New York; May 8, at 7:40–7:45, Eastern Daylight Time, "The Role of Minerals in the Present International Situation," by C. K. LEITH, University of Wisconsin, Madison; May 15, at 7:30–7:45, Eastern Daylight Time, "Geology in the Search for Petroleum," by WILLIAM B. HEROY, Pilgrim Exploration Company, Houston, Texas; May 22, at 7:30–7:45, Eastern Daylight Time, "Origin of Mountains or How Mountains Rise," by CHESTER R. LONGWELL, Yale University; May 29, at 7:30–7:45, Eastern Daylight Time, "Geology in Engineering," by CHARLES P. BERKEY, Columbia University, New York; June 5, at 7:30–7:45, Eastern Daylight Time, "New Uses for Old Minerals," by EDWARD H. KRAUS, University of Michigan; June 12, at 7:30–7:45, Eastern Daylight Time, "The Geologic

Meaning of Deep Earthquakes," by LOUIS B. SLICHTER, Massachusetts Institute of Technology.

E. E. MCDERMOTT, president of Geophysical Service, Inc., Dallas, Texas, addressed the Houston Geological Society, April 6, on "Concentration of Hydrocarbons in the Earth."

L. R. LAUDON, associate professor of geology at the University of Tulsa, talked on "Mississippian Stratigraphy of North America," before the Kansas Geological Society at Wichita, early in April.

CHARLES M. RATH, consulting geologist, spoke before the Rocky Mountain Geological Society at Denver, Colorado, on "The Area Surrounding the Lance Creek Field Wyoming," April 17.

A. K. MILLER, of the State University of Iowa, talked before the Tulsa Geological Society, April 17, on "The Permian of Southwest Coahuila and Its Ammonoid Fauna."

W. ARMSTRONG PRICE, consulting geologist, has returned to Corpus Christi, Texas, after spending 6 weeks in field work on the Staked Plains in West Texas and New Mexico. He has moved his office in Corpus Christi to the Texas Building.

The Shreveport Geological Society announces its 14th annual field trip, June 2, 3, and 4, to study the Upper and Lower Cretaceous of South Arkansas and North Louisiana. An informal meeting outlining the trip will be held at the Grimm Hotel, Texarkana. The party will leave Texarkana by bus early Friday morning, June 2. The night will be spent at Hot Springs, Arkansas, where the headquarters hotel is the Arlington. A route map and twenty supplementary papers, maps and sections will form a guide book which may be ordered for $3.00. Orders, reservations for the trip, hotels and requests for other information should be sent immediately to E. F. MILLER, secretary-treasurer of the Shreveport Geological Society, 911 Commercial National Bank Building, Shreveport, Louisiana.

STANLEY SIEGFUS of Bakersfield, California, has gone to Venezuela. His address is Socony-Vacuum Oil Company, Apartado 246, Caracas, Venezuela.

J. E. ELLIOTT and F. C. MERRITT, of the Elliott Core Drilling Company, Los Angeles, California, are now associated with the Byron Jackson Company which has purchased the Elliott Core Drilling Company and will continue the manufacture and sale of Elliott core drills.

M. R. SPAHR, formerly with the Standard Oil Company of Louisiana, at Shreveport, is with the Carter Oil Company at Tulsa, Oklahoma.

S. D. BUTCHER, who has been in charge of the land department of the Midstates Oil Corporation, Houston, Texas, has resigned and plans to enter the oil business as an independent operator.

JAMES W. HUNTER has been transferred from the Standard Oil Company of Venezuela, at Caripito, to the Netherland Guiana Petroleum Company, Box 457, Paramaribo, Suriname, N. G.

BENNETT FRANK BUIE, formerly at Harvard University, is with the Indian Oil Concessions Ltd., Karachi, India.

P. E. NOLAN, of the Mene Grande Oil Company, has moved from Maracaibo to Caracas, Apartado 709, Venezuela.

ALFRED P. FREY has left Zürich, Switzerland, and may be addressed in care of Bataafsche Petroleum Mij., Carel van Bylandtlaan 30, The Hague, Netherlands.

W. R. RANSONE has changed his address from Venezuela to Geophysical Service, Inc., 1311 Republic Bank Building, Dallas, Texas.

N. J. M. TAVERNE has returned from Papua to Holland. His address is Bataafsche Petroleum Maatschappy, 30 Carel van Bylandtlaan, The Hague.

JOHN L. RICH, professor of economic geology, University of Cincinnati, who, with his wife and daughter is spending a sabbatical leave in South America, reports as one of the high lights of the trip a journey from Buenos Aires to the Commodoro Rivadavia oil fields as guests of the Yacimientos Petroliferos Fiscales, the Government's oil company, on two of their newest tankers. Y.P.F. is engaging in an active search for new oil fields in which American geologists are taking an active part under the direction of GLEN M. RUBY.

The third World Petroleum Congress is scheduled to take place in Berlin, June 9–15, 1940, as recently announced by HERBERT KAHNO, general secretary, Dorotheenstrasse 36, Berlin NW. 7. The organization of the congress is in the hands of the Deutsche Gesellschaft für Mineralölforschung. The membership fee will probably be RM 20 and for ladies accompanying members, RM 10. The final date for registration is April 1, 1940; for forwarding manuscripts, February 1, 1940.

The Sixth Pacific Science Congress will be held, July 24 to August 12, 1939, at Berkeley, Stanford, and San Francisco, California, under the auspices of the National Research Council of the United States of America, Washington, D. C. Stanford University and the University of California are the host institutions. The Golden Gate International Exposition will assist. The sessions of the first period of the Congress, July 24 to August 5, will be held mainly at Berkeley. The second period, August 6 to 12, will be at Stanford. Subjects to be considered include the structure, dynamics, geophysics, and geology of the Pacific Basin; the properties, dynamics, life, and oceanography of the Pacific Ocean; the meteorology, paleontology, and paleobotany of the Pacific climates; and many others bearing on man and culture in the Pacific region. President Ley of The American Association of Petroleum Geologists has appointed ROY M. BARNES, HAROLD W. HOOTS, and MAX L. KRUEGER, of Los Angeles, and STANLEY G. WISSLER, of Compton, California, to represent the Association at the Congress. Information about registration, accommodations, and details of the program may be obtained from the office of the secretary of the Congress, 205 Hilgard Hall, University of California, Berkeley.

LLOYD M. PYEATT, recently with the Union Producing Company at Beeville, Texas, is paleontologist with the Atlantic Refining Company at Houston.

W. HEGWEIN is geologist with Astra Romana, S. A., Campina, Roumania.

H. H. SUTER, recently with the North Venezuelan Petroleum Company at Puerto Cabello, is in the geological department of Trinidad Leaseholds Ltd., Pointe-a-Pierre, Trinidad, B. W. I.

GEORGE A. KROENLEIN has moved from Lovington, New Mexico, to Effingham, Illinois, where his address is in care of the Midland Exploration Company, Box 264, Effingham.

J. H. PAGE, Wichita, Kansas, is gas conservation director of the Kansas Corporation Commission.

VERNON L. KING, consulting petroleum geologist, has recently moved his office to 401 Haas Building, Los Angeles.

HAROLD M. PRESTON, formerly petroleum engineer for the California State Mining Bureau, is associated with King.

PHIL MARTYN, of the Houston Oil Company, talked before the Houston Geological Society, April 18, on "Middle Catahoula and Associated Formations."

WALTON SUMNER has accepted a position with the Socony-Vacuum de Colombia at Bogota, Colombia.

ROBERT M. KLEINPELL, of Bakersfield, California, has gone to Manila, Philippine Islands, for the National Development Company.

E. W. ELLSWORTH, secretary-treasurer of the Illinois Geological Society, reports the meeting of the society at Olney, Illinois, April 21. Approximately 100 geologists of the tri-state area attended this meeting featuring the presentation of a panel on the Pennsylvanian of the Illinois, Indiana, Kentucky basin. MARVIN J. WELLER, of the Illinois State Geological Survey, discussed the correlation of the Pennsylvanian section in Illinois, pointing out that correlation by cyclotherms, representing repetition of cycles of similar deposition, is more applicable than by single beds of coal, sandstone, or limestone. CLYDE A. MALOTT, of the department of geology of the University of Indiana, presented his correlations of the Lower Pennsylvanian exposed along the Ohio River and elsewhere in southern Indiana. RALPH E. ESARY, state geologist of Indiana, discussed the outcrops of the principal Pennsylvanian coal-producing beds of Indiana. A. H. BELL, head of the Oil and Gas Division of the Illinois Survey, reported more than half of the oil produced in Illinois has been produced from beds of Pennsylvanian age. J. REX MCGEHEE announced that the geologists of Centralia would sponsor a dinner preceding the meeting of the society in Centralia, May 26.

E. V. FORAN, of the firm of Parker, Foran, Knode, and Boatwright, read a paper, "Production and Appraisal Methods in Distillate Type Pools," at a recent meeting of the South Texas Geological Society.

EMBY KAY, of the Tide Water Associated Oil Company, talked on "Recovery of Condensate from Distillate Wells," at the meeting of the Shreveport Geological Society last month.

JOHN VAN SANT, geologist for the J. M. Huber Corporation of Borger, Texas, is temporarily located at Lance Creek, Wyoming.

OLIVER T. JOY, of Lincoln, Nebraska, has gone to Buenos Aires to work for the Y.P.F. in Argentina.

J. MARVIN WELLER, of the Illinois Geological Survey, Urbana, spoke before the Tulsa Geological Society, May 1, on "Geological Exploration in Northwestern China."

R. J. FORSYTH, of the Seaboard Oil Company, has been transferred from Dallas, Texas, to Mattoon, Illinois. He has resigned as secretary-treasurer of the Dallas Petroleum Geologists.

HENRY J. MORGAN, JR., of the Atlantic Refining Company, Dallas, Texas, has been appointed secretary-treasurer of the Dallas Petroleum Geologists, succeeding R. J. FORSYTH, resigned.

J. S. HOLLISTER, of Los Angeles, California, has gone to the Philippines for a year.

GRANT W. CORBY, of Los Angeles, has returned to the Philippines, where he has charge of work for the Philippine government, surveying the oil resources of the islands. His address for the coming year is Box 2540, Manila, P. I.

DORSEY HAGER, consulting geologist and petroleum engineer of Centralia, Illinois, delivered a talk on "Petroleum Possibilities of Illinois," before a joint meeting of United Engineering Clubs of Springfield, Illinois, held at the Hotel Abraham Lincoln, in Springfield, April 18. The talk was illustrated with slides.

DON G. BENSON has moved from Baton Rouge, Louisiana, to Houston, Texas. He is with the Sinclair Prairie Oil Company.

GILMAN A. BERG is geologist with the Standard Oil Company of Texas, at Houston.

NEVIN M. FENNEMAN, professor of geology at the University of Cincinnati and post-president of the Geological Society of America, gave a series of lectures to the faculty and students of the department of geology at the University of Kansas during the week of April 17. The lectures were arranged on an exchange basis with the department of geology at the University of Cincinnati. KENNETH K. LANDES, assistant director of the Kansas Geological Survey, will give a similar series of lectures in Cincinnati next fall. The titles of Fenneman's lectures follow: "Appalachian History," "The Appalachian Plateaus (Problems)," "The Great Lakes Section (of the Central Lowland)," and "The Infancy of Geology."

DONALD MAC KAY has a consulting office with Maurice Grubb at 601 National Standard Building, Houston, Texas.

L. C. DECIUS, a vice-president of the Tide Water Associated Oil Company, is also a director and vice-president of the West Coast Oil Company and the Pantheon Oil Company, and a vice-president of the Sterling Oil and Development Company, all subsidiaries of the Tide Water.

FRED H. KAY, vice-president of the Huasteca Petroleum Company, New York, has returned after staying in Venezuela several months.

PHILIP B. KING, geologist of the United States Geological Survey, talked on "Some Features of the West Texas Permian" before the Panhandle Geological Society, at Amarillo, Texas, May 1.

On April 28–29, 1939, the North Texas Geological Society, of Wichita Falls, sponsored a field trip in southwestern Oklahoma and the adjacent areas in Texas. About 45 geologists attended the trip. A general round table discussion was held in the evenings at Vernon, Texas, and Mangum, Oklahoma. At these meetings the essential stratigraphic problems which were to be covered the next day were outlined.

The object of the first day was a detailed study of the Permain beds from the base of the San Angelo up to the base of the Custer group. To the above series of stratigraphic units the name Pease River group has been applied in Texas. This group is to be described by H. C. FOUNTAIN in a forthcoming paper. The type exposures are along the Pease River in Hardeman and Cottle counties, Texas. It was demonstrated in tracing the Pease River group northward from Texas to Mangum, Oklahoma, that it contains a portion if not all of the Duncan sandstone, all of the Flowerpot shale, Blaine, and Dog Creek shale up to the base of the Marlow or Custer group in Oklahoma and Kansas. The leader for the first day was H. C. FOUNTAIN of Wichita Falls, Texas.

The object of the second day was a detailed stratigraphic study of the Custer and Dockum groups. It was demonstrated in the field that the Whitehorse and Quartermaster as now defined in Oklahoma are present in Texas and are a part of the Custer group. Also the total thickness of the Custer group in Texas has greatly increased over what it is in Oklahoma and Kansas. This is due in part to the addition of beds and in part to the thickening of individual members. The upper portion of the Dockum group was not examined in detail. The leader for the second day was ROBERT ROTH of Wichita Falls, Texas. The committee in charge of the trip was: H. C. FOUNTAIN, chairman, ROBERT ROTH, and KARL A. MYGDAL. The officers of the North Texas Geological Society are: president, TOM F. PETTY, Humble Oil and Refining Company; vice-president, PAUL E. M. PURCELL, 701 Hamilton Building; secretary-treasurer, ORION A. DANIEL, 814 Hamilton Building, Wichita Falls, Texas.

STANLEY C. HEROLD has recently opened a consulting office at 811 West Seventh Street, Los Angeles, California. He is specializing on field exploitation problems pertaining to the increase of recovery, control of water encroachment, conservation of gas energy, reduction of average production costs, pressure maintenance, and secondary methods of recovery.

PROFESSIONAL DIRECTORY

Space for Professional Cards Is Reserved for Members of the Association. For Rates Apply to A.A.P.G. Headquarters, Box 979, Tulsa, Oklahoma

CALIFORNIA

WILLARD J. CLASSEN
Consulting Geologist
Petroleum Engineer
1093 Mills Building
SAN FRANCISCO, CALIFORNIA

RICHARD R. CRANDALL
Consulting Geologist
404 Haas Building
LOS ANGELES, CALIFORNIA

J. E. EATON
Consulting Geologist
2062 N. Sycamore Avenue
LOS ANGELES, CALIFORNIA

PAUL P. GOUDKOFF
Geologist
Geologic Correlation by Foraminifera and Mineral Grains
799 Subway Terminal Building
LOS ANGELES, CALIFORNIA

VERNON L. KING
Petroleum Geologist and Engineer
401 Hass Building
LOS ANGELES, CALIFORNIA

CHAS. GILL MORGAN
United Geophysical Company
Pasadena California

WALTER STALDER
Petroleum Geologist
925 Crocker Building
SAN FRANCISCO, CALIFORNIA

R. L. TRIPLETT
Contract Core Drilling
WHitney 9876
2013 West View St.
LOS ANGELES, CALIF.

R. W. SHERMAN
Consulting Geologist
Pacific Mutual Building
523 West Sixth St.
LOS ANGELES

COLORADO

HEILAND RESEARCH CORPORATION
Registered Geophysical Engineers
— *Instruments* —
— Surveys — Interpretations —
C. A. Heiland, *President* — Club Bldg., Denver, Colo.

CUBA

R. H. PALMER
Petroleum Geologist
Examinations and Reports on Cuban Oil Lands
Neptuno 1060 — Habana, Cuba

KANSAS

HOLL AND OBORNE
Consulting Geologists
F. G. Holl, 4121 East English, Wichita, Kansas
Harry W. Oborne, 1328 North Tejon St., Colorado Springs, Colo.

MARVIN LEE
Consulting Petroleum Geologist
1109 Bitting Building
Wichita, Kansas
Office: 3-8941 — *Residence:* 4-4873
Geology and production problems of oil and gas in the United States
Formerly Technical Adviser to State Corporation Commission. Official mail should be addressed to the Commission.

L. C. MORGAN
Petroleum Engineer and Geologist
Specializing in Acid-Treating Problems
358 North Dellrose
Wichita, Kansas

LOUISIANA

WILLIAM M. BARRET, INC.
Consulting Geophysicists
Specializing in Magnetic Surveys
Giddens-Lane Building — Shreveport, La.

MICHIGAN

WILLIAM F. BROWN
Consulting Geologist
Box 302 — Mount Pleasant, Mich.

NEW MEXICO

RONALD K. DeFORD
Geologist
Roswell, New Mexico — Midland, Texas

NEW YORK

FREDERICK G. CLAPP
Consulting Geologist
50 Church Street
NEW YORK

BROKAW, DIXON & McKEE
Geologists — *Engineers*
OIL—NATURAL GAS
Examinations, Reports, Appraisals
Estimates of Reserves
120 Broadway, New York — Gulf Building, Houston

NEW YORK

A. H. GARNER
Geologist *Engineer*
PETROLEUM
NATURAL GAS
120 Broadway New York, N.Y.

OHIO

JOHN L. RICH
Geologist
Specializing in extension of "shoestring" pools
University of Cincinnati
Cincinnati, Ohio

OKLAHOMA

ELFRED BECK
Geologist
717 McBirney Bldg.
TULSA, OKLA.
1222-A Republic Natl. Bank Bldg.
DALLAS, TEX.

GINTER LABORATORY
CORE ANALYSES
Permeability
Porosity
Reserves
R. L. GINTER
Owner
118 West Cameron, Tulsa

MALVIN G. HOFFMAN
Geologist
Midco Oil Corporation
Midco Building
TULSA, OKLAHOMA

R. W. Laughlin L. D. Simmons
WELL ELEVATIONS
Oklahoma, Kansas, Texas, and New Mexico
LAUGHLIN-SIMMONS & CO.
605 Oklahoma Gas Building
TULSA OKLAHOMA

MID-CONTINENT TORSION BALANCE SURVEYS
SEISMIC AND GRAVITY INTERPRETATIONS
KLAUS EXPLORATION COMPANY
H. KLAUS
Geologist and Geophysicist
Broadway Tower
Enid, Okla.
Benson Building
Lubbock, Texas

A. I. LEVORSEN
Petroleum Geologist
221 Woodward Boulevard
TULSA OKLAHOMA

GEO. C. MATSON
Geologist
Philcade Building TULSA, OKLA.

G. H. WESTBY
Geologist and Geophysicist
Seismograph Service Corporation
Kennedy Building Tulsa, Oklahoma

PENNSYLVANIA

HUNTLEY & HUNTLEY
Petroleum Geologists and Engineers
L. G. HUNTLEY
J. R. WYLIE, JR.
Grant Building, Pittsburgh, Pa.

TEXAS

JOSEPH L. ADLER
Geologist and Geophysicist
Consultant and Contractor in Geological and Geophysical Exploration
323 Esperson Bldg.
HOUSTON, TEXAS

MID-CONTINENT TORSION BALANCE SURVEYS
SEISMIC AND GRAVITY INTERPRETATIONS
KLAUS EXPLORATION COMPANY
H. KLAUS
Geologist and Geophysicist
Broadway Tower, Enid, Okla. — Benson Building, Lubbock, Texas

DONALD C. BARTON
Geologist and Geophysicist
Humble Oil and Refining Company
HOUSTON TEXAS

D'ARCY M. CASHIN
Geologist *Engineer*
Specialist, Gulf Coast Salt Domes
Examinations, Reports, Appraisals
Estimates of Reserves
705 Nat'l. Standard Bldg.
HOUSTON, TEXAS

E. DEGOLYER
Geologist
Esperson Building
Houston, Texas
Continental Building
Dallas, Texas

ALEXANDER DEUSSEN
Consulting Geologist
Specialist, Gulf Coast Salt Domes
1006 Shell Building
HOUSTON, TEXAS

DAVID DONOGHUE
Consulting Geologist
Appraisals - Evidence - Statistics
Forth Worth National Bank Building — FORT WORTH, TEXAS

F. B. Porter, *President* — R. H. Fash, *Vice-President*
THE FORT WORTH LABORATORIES
Analyses of Brines, Gas, Minerals, Oil, Interpretation of Water Analyses. Field Gas Testing.
828½ Monroe Street FORT WORTH, TEXAS
Long Distance 138

J. S. HUDNALL — G. W. PIRTLE
HUDNALL & PIRTLE
Petroleum Geologists
Appraisals Reports
Peoples Nat'l. Bank Bldg. TYLER, TEXAS

JOHN S. IVY
Geologist
921 Rusk Building, HOUSTON, TEXAS

W. P. JENNY
Geologist and Geophysicist
Gravimetric Seismic
Magnetic Electric
Surveys and Interpretations
907 Sterling Bldg. HOUSTON, TEXAS

GEO. C. McGHEE
Geologist and Geophysicist
NATIONAL GEOPHYSICAL COMPANY
Tower Petroleum Building
DALLAS, TEXAS

DABNEY E. PETTY
315 Sixth Street
SAN ANTONIO, TEXAS
No Commercial Work Undertaken

E. E. ROSAIRE
SUBTERREX
BY
Geophysics and Geochemistry
Esperson Building Houston, Texas

A. T. SCHWENNESEN
Geologist
1517 Shell Building
HOUSTON TEXAS

ROBERT H. DURWARD
Geologist
Specializing in use of the magnetometer and its interpretations
1431 W. Rosewood Ave. San Antonio, Texas

W. G. SAVILLE J. P. SCHUMACHER A. C. PAGAN
TORSION BALANCE EXPLORATION CO.
Torsion Balance Surveys
1404-10 Shell Bldg. Phone: Capitol 1541
HOUSTON TEXAS

HAROLD VANCE
Petroleum Engineer
Petroleum Engineering Department
A. & M. College of Texas
COLLEGE STATION, TEXAS

CUMMINS & BERGER
Consultants
Specializing in Valuations
Texas & New Mexico
1601-3 Trinity Bldg. Ralph H. Cummins
Fort Worth, Texas Walter R. Berger

WM. C. McGLOTHLIN
Petroleum Geologist and Engineer
Examinations, Reports, Appraisals
Estimates of Reserves
Geophysical Explorations
806 State Nat'l. Bank Bldg., CORSICANA, TEXAS

FRANK C. ROPER JOHN D. TODD
ROPER & TODD
Specializing Sparta
Wilcox Trend Problems
527 Esperson Bldg. Houston, Texas

WEST VIRGINIA

DAVID B. REGER
Consulting Geologist
217 High Street
MORGANTOWN WEST VIRGINIA

WYOMING

E. W. KRAMPERT
Geologist
P.O. Box 1106
CASPER, WYOMING

DIRECTORY OF GEOLOGICAL AND GEOPHYSICAL SOCIETIES

For Space Apply to A.A.P.G. Headquarters
Box 979, Tulsa, Oklahoma

COLORADO

ROCKY MOUNTAIN ASSOCIATION OF PETROLEUM GEOLOGISTS
DENVER, COLORADO

President - - - - - Warren O. Thompson
985 Gilbert Street, Boulder
1st Vice-President - - - - David B. Miller
1336 Gaylord Street
2nd Vice-President - - - Harold N. Hickey
810 U. S. National Bank Building
Secretary-Treasurer - - - - - - Ninetta Davis
224 U. S. Customs Building

Dinner meetings, first and third Mondays of each month, 6:15 P.M., Auditorium Hotel.

KANSAS

KANSAS GEOLOGICAL SOCIETY
WICHITA, KANSAS

President - - - - - - Geo. H. Norton
Atlantic Refining Company
Vice-President - - - - - Thomas H. Allan
Consulting Geologist
Secretary-Treasurer - - - - E. Gail Carpenter
Consulting Geologist
Manager of Well Log Bureau - Harvel E. White

Regular Meetings: 7:30 P.M., Allis Hotel, first Tuesday of each month. Visitors cordially welcomed.

The Society sponsors the Kansas Well Log Bureau which is located at 412 Union National Bank Building.

LOUISIANA

THE SHREVEPORT GEOLOGICAL SOCIETY
SHREVEPORT, LOUISIANA

President - - - - - - - - - - C. C. Clark
Union Producing Company
Vice-President - - - - - - - - L. S. Harlowe
Grogan Oil Company
Secretary-Treasurer - - - - - - E. F. Miller
Bay Oil Corporation, 911 Commercial Bank

Meets the first Friday of every month, 7:30 P.M., Civil Courts Room, Caddo Parish Court House. Special dinner meetings by announcement.

SOUTH LOUISIANA GEOLOGICAL SOCIETY
LAKE CHARLES, LOUISIANA

President - - - - - - - - Dean F. Metts
Humble Oil & Refining Co., Crowley, La.
Vice-President - - - - - H. E. McGlasson
Stanolind Oil and Gas Company
Secretary - - - - - - - - G. O. Grigsby
Stanolind Oil and Gas Company
Treasurer - - - - - - - - Baker Hoskins
Shell Oil Company, Inc.

Meetings: Luncheon 1st Wednesday at Noon (12:00) and business meeting third Tuesday of each month at 7.00 P.M. at the Majestic Hotel. Visiting geologists are welcome.

MICHIGAN

MICHIGAN GEOLOGICAL SOCIETY

President - - - - - - - Carl C. Addison
The Pure Oil Company, Saginaw
Vice-President - - - - - - Jed B. Maebius
Gulf Oil Corporation, Saginaw
Secretary-Treasurer - - - - - R. P. Grant
Michigan Geological Survey, Lansing
Business Manager - - - - - Helen Martin
Michigan Geological Survey

Meetings: Monthly dinner meetings rotating between Saginaw, Mt. Pleasant, and Lansing. Informal dress.

OKLAHOMA

ARDMORE GEOLOGICAL SOCIETY
ARDMORE, OKLAHOMA

President - - - - - - - - - - Don L. Hyatt
Carter Oil Company

Vice-President - - - - - - - - - J. P. Gill
Sinclair Prairie Oil Company

Secretary-Treasurer - - - W. Morris Guthrey
The Texas Company

Meetings: First Tuesday of each month, from October to May, inclusive, at 7:30 P.M., Dornick Hills Country Club.

OKLAHOMA CITY GEOLOGICAL SOCIETY
OKLAHOMA CITY, OKLAHOMA

President - - - - - - - - - Dan O. Howard
Oklahoma Corporation Commission

Vice-President - - - - Albert S. Clinkscales
Consulting Geologist, Colcord Building

Secretary-Treasurer - - - - - - R. Hancock
Magnolia Petroleum Corporation

Meetings, Ninth Floor, Commerce Exchange Building: Technical Program, second Monday, each month, 8:00 P.M.; Luncheons, every Monday, 12:15 P.M.

SHAWNEE GEOLOGICAL SOCIETY
SHAWNEE, OKLAHOMA

President - - - - - - Roy P. Lehman
Phillips Petroleum Company

Vice-President - - - - - J. Lawrence Muir
Amerada Petroleum Corporation

Secretary-Treasurer - - - - Tom L. Girdler, Jr.
Sinclair Prairie Oil Company

Meets the fourth Monday of each month at 8:00 P.M., at the Aldridge Hotel. Visiting geologists welcome.

THE STRATIGRAPHIC SOCIETY OF TULSA
TULSA, OKLAHOMA

President - - - - - - - - - L. H. Lukert
The Texas Company

Vice-President - - - - - - - L. A. Johnston
Sunray Oil Company

Secretary-Treasurer - - Constance Leatherock
Tide Water Associated Oil Company

Meetings: Second and fourth Wednesdays, each month, from October to May, inclusive, at 8:00 P.M.

TULSA GEOLOGICAL SOCIETY
TULSA, OKLAHOMA

President - - - - - - - - - Robert H. Wood
Wood Brothers

1st Vice-President - - - - - - Charles Ryniker
Gulf Oil Corporation

2nd Vice-President - - - - - J. D. McClure
Barnsdall Oil Company

Secretary-Treasurer - - - Merritt H. Brown
Darby Petroleum Corporation

Editor - - - - - - - - - - - J. M. Clark
Tide Water Associated Oil Company

Associated Editor - - - - - Maurice R. Teis
Homestake Companies

Meetings: First and third Mondays, each month, from October to May, inclusive, at 8:00 P.M., University of Tulsa, Tyrell Hall Auditorium. Luncheons: Every Thursday, Michaelis Cafeteria, 507 South Boulder Avenue.

TEXAS

DALLAS PETROLEUM GEOLOGISTS
DALLAS, TEXAS

President - - - - - - - - - R. E. Rettger
Sun Oil Company

Vice-President - - - - - - W. W. Clawson
Magnolia Petroleum Company

Secretary-Treasurer - - - Henry J. Morgan, Jr.
Atlantic Refining Company

Executive Committee - - - Eugene McDermott

Meetings: Regular luncheons, first Monday of each month, 12:15 noon, Petroleum Club. Special night meetings by announcement.

EAST TEXAS GEOLOGICAL SOCIETY
TYLER, TEXAS

Presidents - - - - - - - - A. C. Wright
Shell Oil Company, Inc.

Vice-President - - - - - - - E. M. Rice
Pure Oil Company

Secretary-Treasurer - - - - - F. J. Schempf
Stanolind Oil and Gas Company

Meetings: Monthly and by call.
Luncheons: Every Friday, Blue Room, Blackstone Hotel.

TEXAS

FORT WORTH GEOLOGICAL SOCIETY
FORT WORTH, TEXAS

President . . . . . J. Earle Brown
Consulting Geologist, Trinity Life Building

Vice-President . . . . . J. H. Markley
The Texas Company

Secretary-Treasurer . . . . Vernon Lipscomb
The Pure Oil Company

Meetings: Luncheon at noon, Worth Hotel, every Monday. Special meetings called by executive committee. Visiting geologists are welcome to all meetings.

HOUSTON GEOLOGICAL SOCIETY
HOUSTON, TEXAS

President . . . . . David Perry Olcott
Humble Oil and Refining Company

Vice-President . . . . . R. A. Weingartner
Stanolind Oil and Gas Company

Secretary-Treasurer . . . Carleton D. Speed, Jr.
Speed Oil Company

Regular meetings held every Thursday at noon (12 o'clock) above Kelly's Restaurant, 910 Texas Avenue. For any particulars pertaining to the meetings write of call the secretary.

NORTH TEXAS GEOLOGICAL SOCIETY
WICHITA FALLS, TEXAS

President . . . . . Tom F. Petty
Humble Oil & Refining Company

Vice-President . . . . Paul E. M. Purcell
701 Hamilton Building

Secretary-Treasurer . . . Orion A. Daniel
Consulting Geologist
814 Hamilton Building

Luncheons and evening programs will be announced.

SOUTH TEXAS GEOLOGICAL SOCIETY
SAN ANTONIO AND CORPUS CHRISTI TEXAS

President . . . . . Willis Storm
1733 Milam Building, San Antonio

Vice-President . . . . . Dale L. Benson
Sinclair Prairie Oil Company, Corpus Christi

Secretary-Treasurer . . . . Ira A. Brinkerhoff
Stanolind Oil and Gas Company, San Antonio

Executive Committee . . . . . E. L. Porch

Meetings: Third Friday of each month at 8 P.M. at the Petroleum Club. Luncheons every Monday noon at Petroleum Club, Alamo National Building, San Antonio, and at Plaza Hotel, Corpus Christi.

SOUTHWESTERN GEOLOGICAL SOCIETY

President . . . . . Duncan McConnell
Univ. Texas, Dept. of Geology

Vice-President . . . . . Leo Hendricks
Bureau of Economic Geology

Secretary-Treasurer . . . . . W. C. Ikins
Univ. Texas, Dept. of Geology

Meetings: Every third Friday at 8:00 P.M. at the University of Texas, Geology Building 14.

WEST TEXAS GEOLOGICAL SOCIETY
MIDLAND, TEXAS

President . . . . . Berte R. Haigh
University Lands

Vice-President . . . . . W. C. Fritz
Skelly Oil Company, Midland

Secretary-Treasurer . . . . . J. E. Simmons
Continental Oil Company

Meetings will be announced

WEST VIRGINIA

THE APPALACHIAN GEOLOGICAL SOCIETY
CHARLESTON, WEST VIRGINIA
P.O. Box 1435

President . . . . . Robert C. Lafferty
Owens, Libbey-Owens Gas Department

Vice-President . . . . . J. R. Lockett
Ohio Fuel Gas Company
Columbus, Ohio

Secretary-Treasurer . . . Charles Brewer, Jr.
Godfrey L. Cabot, Inc., Box 348

Meetings: Second Monday, each month, at 6:30 P.M., Kanawha Hotel.

THE SOCIETY OF EXPLORATION GEOPHYSICISTS

President . . . . . E. A. Eckhardt
Gulf Research and Development Company
Pittsburgh, Pennsylvania

Vice-President . . . . . W. T. Born
Geophysical Research Corporation
Tulsa, Oklahoma

Editor . . . . . R. D. Wyckoff
Gulf Oil Corporation, Houston, Texas

Secretary-Treasurer . . . . J. H. Crowell
Independent Exploration Company, Houston, Texas

TRIANGLE BLUE PRINT & SUPPLY COMPANY

Representing
W. & L. E. Gurley
Spencer Lens American Paulin

Complete Reproduction Plant
Instruments Repaired

12 West Fourth Street, Tulsa, Oklahoma

GEOGEL *HI SPEED*

GEOTUBE

ILLINOIS POWDER MFG. CO.

REVUE DE GÉOLOGIE
et des Sciences connexes

RASSEGNA DI GEOLOGIA
e delle Scienze affini

REVIEW OF GEOLOGY
and Connected Sciences

RUNDSCHAU FÜR GEOLOGIE
und verwandte Wissenschaften

Abstract journal published monthly with the coöperation of the FONDATION UNIVERSITAIRE DE BELGIQUE and under the auspices of the SOCIÉTÉ GEOLOGIQUE DE BELGIQUE with the collaboration of several scientific institutions, geological surveys, and correspondents in all countries of the world.

GENERAL OFFICE, *Revue de Géologie*, Institut de Géologie, Université de Liége, Belgium.

TREASURER, *Revue de Géologie*, 35, Rue de Armuriers, Liége, Belgium.

Subscription, Vol. XIX (1939), 35 belgas *Sample Copy Sent on Request*

The Annotated

Bibliography of Economic Geology
Vol. XI, No. 1

Now Ready

Orders are now being taken for the entire volume at $5.00 or for individual numbers at $3.00 each. Volumes I-X can still be obtained at $5.00 each.

The number of entries in Vols. IX and X is 4,997.

Of these, 1,348 refer to *petroleum, gas,* etc., and *geophysics.* They cover the world.

If you wish future numbers sent you promptly, kindly give us a *continuing* order.

An Index of the 10 volumes will be issued in December. Price: $5.00

Economic Geology Publishing Co.
Urbana, Illinois, U.S.A.

For

SEISMOGRAPH RECORDS

use

EASTMAN RECORDING

PAPERS

PREPARED DEVELOPER

AND FIXING POWDERS

Supplied by

EASTMAN KODAK STORES, INC.

1010 Walnut Street Kansas City, Mo.
1504 Young Street Dallas, Texas

SPARTA-WILCOX TREND.....

The results of recent surveys demonstrate that our Magnetometric Method* offers a reliable, rapid and inexpensive means of locating favorable structures in the "Sparta-Wilcox trend."

It is worth your while to consider our service if you are interested in this important area.

•

WILLIAM M. BARRET, INC.
Consulting Geophysicists
GIDDENS - LANE BUILDING
SHREVEPORT, LOUISIANA

**An illustrated booklet describing this method will be mailed on request*

Seismograph Crews

with a long record of efficient field operations and successful interpretations offered for contract work anywhere

INDEPENDENT EXPLORATION COMPANY

ESPERSON BLDG. HOUSTON, TEXAS

PRACTICAL PETROLEUM ENGINEERS' HANDBOOK

BY JOSEPH ZABA, E.M.M.Sc.
Petroleum Engineer, Rio Bravo Oil Company
and
W. T. DOHERTY
Division Superintendent, Humble Oil & Refining Company

For a number of years there has been a growing demand for a handbook containing formulae and other practical information for the benefit of the man working in the production and drilling branches of the oil industry. So great has been this need that many engineers have tried to accumulate their own handbooks by clipping tables, formulae and figures from scores of sources.

The co-authors of this volume discovered by coincidence that each had been for a period of several years accumulating practical data which through their collaboration appears in this book. Both of them are men who have not only received theoretical training but who have had many years of practical experience as engineers in dealing with every day oil field drilling and production problems.

As a result of this collaboration of effort the publishers of this volume feel that it is a most valuable contribution to oil trade literature.

Its purposes are distinctly practical. The tables, formulae, and figures shown are practical rather than theoretical in nature. It should save the time of many a busy operator, engineer, superintendent, and foreman.

TABLE OF CONTENTS

Chapter I—General Engineering Data
Chapter II—Steam
Chapter III—Power Transmission
Chapter IV—Tubular Goods
Chapter V—Drilling
Chapter VI—Production
Chapter VII—Transportation

Semi-Flexible Fabrikoid Binding, Size 6 x 9, 408 pages—Price $5.00 Postpaid

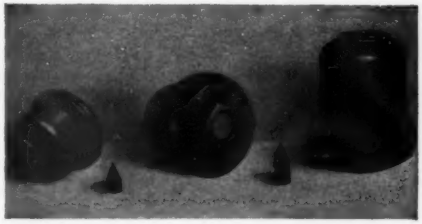
Send check to

THE GULF PUBLISHING COMPANY

P. O. Drawer 2811 Houston, Texas

LANE-WELLS GUN PERFORATING SERVICE IS SAFE, ACCURATE AND POSITIVE IN PENETRATION

Precautions—such as remote controlled firing—make Lane-Wells perforators safe to run and safe to handle. Tests prove their dependability, their power to penetrate. For example, the standard of penetration for a Lane-Wells gun is more than 2.397 inches of cement and steel casing. The Lane-Wells advantages are described in a recent bulletin. Write for it today, Lane-Wells Company, 5610 S. Soto Street, Los Angeles, California.



Right, gun perforator chambers are double sealed against fluid.

LANE-WELLS COMPANY

TECHNICAL OILFIELD SERVICES

GENERAL OFFICES AND PLANT
5610 S. Soto St.
Los Angeles, Calif.

EXPORT OFFICES
420 Lexington Ave.
New York City, N.Y.

GULF COAST OIL FIELDS

A SYMPOSIUM ON THE GULF COAST CENOZOIC

EDITED BY

DONALD C. BARTON

Humble Oil and Refining Company

AND

GEORGE SAWTELLE

Kirby Petroleum Company

1,084 pages, 292 line drawings, 19 half-tone plates. Bound in blue cloth; gold stamped; paper jacket; 6x9 inches.

PRICE: $4.00, EXPRESS OR POSTAGE FREE
($3.00 to A.A.P.G. members and associate members)

AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

Box 979, Tulsa, Oklahoma

GEOLOGY OF NATURAL GAS

EDITED BY HENRY A. LEY

• •

A comprehensive geologic treatise of the occurrence of natural gas on the North American Continent.

• •

1227 pages
250 illustrations
Bound in cloth. 6 x 9 x 2 inches

$4.50 Postpaid

$6.00 to non-members

AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

Box 979, Tulsa, Oklahoma

WE BANK ON OIL
1895 — 1939

THE
FIRST NATIONAL BANK AND TRUST COMPANY
OF TULSA

THE GEOTECHNICAL CORPORATION

Roland F. Beers
President

902 Tower Petroleum Building
Telephone L D 711 Dallas, Texas

Verlag von Gebrüder Borntraeger in Berlin und Leipzig

Einführung in die Geologie, ein Lehrbuch der inneren Dynamik, von Professor Dr. **H. Cloos.** Mit 1 Titelbild, 3 Tafeln und 356 Textabbildungen (XII und 503 Seiten) 1936 Gebunden *RM* 24.—

Das Buch will den überreichen Forschungsstoff der letzten Jahrzehnte so darstellen, daß sich auch Fernerstehende von dem Bau, der stofflichen Zusammensetzung und den Bewegungsvorgängen in der Kruste unseres Planeten ein Bild machen können. Die Darstellung geht überall von den Tatsachen und zwar, so weit wie möglich, von den tatsächlichen Bewegungen aus und endigt bei ihrer gedanklichen Auswertung. Auf die Interessen der Praxis, besonders des Bergbaus, ist überall Bezug genommen, die Verbindung mit dem Leben nach Möglichkeit ständig gewahrt. Das Buch sollte auch den nicht mit gelehrtem Gepäck belasteten Wanderer im Gebirge führen können.

Die Beispiele stammen aus allen Teilen der Erde, nicht zuletzt aus Skandinavien, Indien, Nordamerika und Afrika. Aber Deutschland und seine früheren außereuropäischen Besitzungen sind bevorzugt.

Für den Verfasser gibt es in der Erde keine Einzeldinge und nichts Fertiges. Er versucht, die Tatsachen in ihren Zusammenhängen vorzuführen (Bewegungen, Kreisläufe, Abstauungen, Entwicklungen usw.), und möchte alle Erkenntnisse aufgefaßt wissen als Pflastersteine in einer Straße zur Lösung eines letzten, zentralen Problems der Gesamterde. Lücken in diesem Pflaster werden nicht überkleistert, sondern deutlich umschrieben. Das Buch will also nicht nur in seinem Stoff ein dynamisches sein.

Ausführliche Einzelprospekte kostenfrei

REFLECTION SEISMOGRAPH SURVEYS

The cumulative experience of a large number of field crews in diverse localities, and constant research in both field and laboratory enable us to render a Seismograph Service which we believe to be unequalled.

Fully experienced crews available for work anywhere in the United States and Foreign Countries.

WESTERN GEOPHYSICAL COMPANY

HENRY SALVATORI, PRESIDENT

EDISON BLDG.
LOS ANGELES, CALIF.

PHILCADE BLDG.
TULSA, OKLAHOMA

Leitz

OIL FIELD MICROSCOPE

It is a full sized wide field binocular and combines the quality of the laboratory microscope with the added advantage of shock proof and dust proof portability.

WRITE FOR CATALOG NO. 9-MY

E. LEITZ, INC. 730 FIFTH AVENUE, NEW YORK, N. Y.
WASHINGTON · CHICAGO · DETROIT
(Makers of the famous LEICA Cameras) Western Agents: Spindler and Sauppe, Inc., Los Angeles - San Francisco

TO AVOID TROUBLE use BAROID PRODUCTS

USE AQUAGEL *for a trouble-free drilling mud and for conditioning.*

USE BAROID *to help prevent blow-outs and to help control caving.*

USE STABILITE *to help prevent gas-cutting and to maintain muds at workable viscosities.*

USE BAROCO *to avoid trouble in drilling through salt and salt water.*

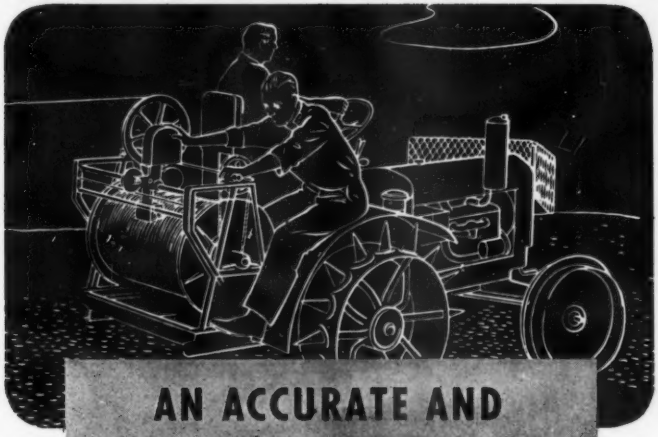
USE FIBROTEX *to help prevent bad losses of circulation.*

Use BAROID Testing Equipment to aid in maintaining the uniform quality of the drilling mud.

Stocks carried and service engineers available in all active oil fields. Look for this trade mark under "Oil Well Drilling Mud" in your classified telephone directory for our nearest service engineer and distributor.

BAROID SALES DEPARTMENT
NATIONAL PIGMENTS & CHEMICAL DIVISION
NATIONAL LEAD COMPANY
BAROID SALES OFFICES—LOS ANGELES · TULSA · HOUSTON

CONTINUOUS *Electrical* PROFILING



AN ACCURATE AND ECONOMICAL METHOD OF STRUCTURAL MAPPING

Over 40 wells drilled in 1938 in the Permian Salt Basin of New Mexico and West Texas continue to show the reliability of this method.

Similar results are being obtained in areas covered with deep glacial or alluvial deposits.

Sole licensees under JAKOSKY Patents, U. S. Nos. 2138818, 2137650, 2105247, 2015401, 1906271 . . . Canadian Patent No. 374475. Other U. S. and Foreign Patents Pending Covering Apparatus and Method.

For Fluid Level Determinations, use the Electrical ECHO-METER. Greatest accuracy is assured with a Steep Front Wave measuring device on which there are U. S. Patents pending covering methods and apparatus.

GEOPHYSICAL EXPLORATION
IGI
INTERNATIONAL Geophysics LOS ANGELES

BRANCH OFFICES: P. O. Box 392, Great Bend, Kansas—P. O. Box 188, Lovington, New Mexico —P. O. Box 1499, Kilgore, Texas.

INTERNATIONAL *Geophysics*, INC.

ORGANIZED IN 1929

1063 GAYLEY AVENUE • LOS ANGELES, CALIFORNIA

FOR LOW COST DISCOVERIES

Your Exploration Campaign Should be Initiated by

Subterrex

using

Stratigraphic Prospecting for Reconnaissance

by

Eltran and Soil Analysis

followed by

Structural Prospecting for Detail

Do You Know

How to estimate discovery costs in advance?

How many discoveries you should reasonably expect for a given appropriation?

The difference between stratigraphic and structural prospecting methods?

The objective of exploration?†

What is the major portion of discovery costs?‡

How to find stratigraphic traps?

The paradox of exploration?

The answers to these questions are interesting as well as stimulating. For instance:

† The objective of exploration is the discovery of petroleum under the most favorable conditions of *time, place, and investment!*

‡ The major portion of discovery costs is the recognition of *unfavorable* acreage!

Write us for our answers to these and other exploration problems, both general and specific. You will find our advice, experience, and facilities such as to be of material importance in the discovery of petroleum under the most favorable conditions of investment, leaving your problem only the choice of the most favorable time and place.

Subterrex

Address inquiries to Dr. E. E. Rosaire, Sole Owner, Esperson Bldg., Houston, Texas, U.S.A.

Basic and improvement patents issued and/or pending in the United States and Foreign Countries.

BY ELTRAN & SOILANE

THE GEOLOGY OF SOUTH-WESTERN ECUADOR

BY
GEORGE SHEPPARD
State Geologist of the Republic of Ecuador
With a chapter on THE TERTIARY LARGER FORAMINIFERA OF ECUADOR
By THOMAS WAYLAND VAUGHAN
Director of the Scripps Institution of Oceanography, LaJolla, California

The first book on the geology of Ecuador to be published in English.
The author has spent 10 years in studying the area.
The chapters on petroleum and on the foraminifera are of special interest to oil-field geologists.
The book is also of interest to geographers.
Published by Thomas Murby & Co., in London, 1937.

275 pp., 195 illustrations, maps, and diagrams. 5½ x 8½ inches. Cloth.
PRICE: Postpaid and import duty paid, $7.00
Specimen pages sent on request

ORDER FROM The American Association of Petroleum Geologists
Box 979, Tulsa, Oklahoma

GEOLOGY OF THE TAMPICO REGION, MEXICO

By JOHN M. MUIR

PART I. INTRODUCTORY. History. Topography. Drainage. (Pages 1-6.)
PART II. STRATIGRAPHY AND PALAEOGEOGRAPHY. Palaeozoic. Mesozoic. Tertiary. (7-142.)
PART III. IGNEOUS ROCKS AND SEEPAGES. Asphalt. Oil. Gas. (143-158.)
PART IV. GENERAL STRUCTURE AND STRUCTURE OF OIL FIELDS. Northern Fields and Southern Fields: Introduction, Factors Governing Porosity, Review of Predominant Features, Production, Description of Each Pool and Field, Natural Gas, Light-Oil Occurrences. (159-225.)
APPENDIX. Oil Temperatures. Salt-Water Temperatures. Well Pressures. Stripping Wells. Shooting and Acid Treating. Stratigraphical Data in Miscellaneous Areas. List of Wells at Tancoco. (226-236.)
BIBLIOGRAPHY (237-247). LIST OF REFERENCE MAPS (248). GAZETTEER (249-250). INDEX (251-280).

- **280 pages, including bibliography and index**
- **15 half-tones, 41 line drawings, including 5 maps in pocket**
- **212 references in bibliography**
- **Bound in blue cloth; gold stamped; paper jacket. 6 x 9 inches**

$4.50, post free
$3.50 to A.A.P.G. members and associates

The American Association of Petroleum Geologists
BOX 979, TULSA, OKLAHOMA, U.S.A.

Schlumberger

ELECTRICAL WELL LOGGING

•

SIDE WALL SAMPLING

•

PRECISION GUN PERFORATING

•

The same processes are applied outside the U. S. A.
by Societe de Prospection Electrique, 30 Rue Fabert, Paris, France.

More Vivid Stereoscopic Images

increase accuracy of observations

Perspective and depth of focus are important requisites in the study of well borings.

Spencer Low Power Binocular Microscopes provide a wide field of view and great depth of focus. They produce a more vivid stereoscopic image because the objectives converge at a 16 degree angle—an exclusive Spencer feature. The eye pieces, however, converge at the comfortable angle of 8 degrees eliminating eye-strain and fatigue.

A dust-tight revolving drum carrying objectives of different magnifications is available.

Using one of these instruments brings a full realization of the real value of these Spencer features.

Write Dept. S29 for descriptive literature.

Spencer Lens Company

MICROSCOPES
MICROTOMES
PHOTOMICROGRAPHIC EQUIPMENT

SPENCER BUFFALO U.S.A.

REFRACTOMETERS
COLORIMETERS
SPECTROMETERS
PROJECTORS

ONLY ONE STRING TO YOUR BOW?

WE CAN OFFER YOU EFFICIENT SERVICE IN
ALL MODERN GEOPHYSICAL METHODS

FIFTEEN YEARS WORLD-WIDE EXPERIENCE ENABLES
US TO CHOOSE THE TECHNIQUE BEST SUITED
TO YOUR PARTICULAR PROBLEM

COMPAGNIE GENERALE DE GEOPHYSIQUE

(SCHLUMBERGER METHODS)

30 Rue Fabert, PARIS, FRANCE

SEISMOGRAPH

GRAVIMETER

TORSION BALANCE

MAGNETOMETER

ELECTRICAL RESISTIVITY METHOD

THE ONLY FIRM WITH A LONG EXPERIENCE OF THE D.C. TECHNIQUE

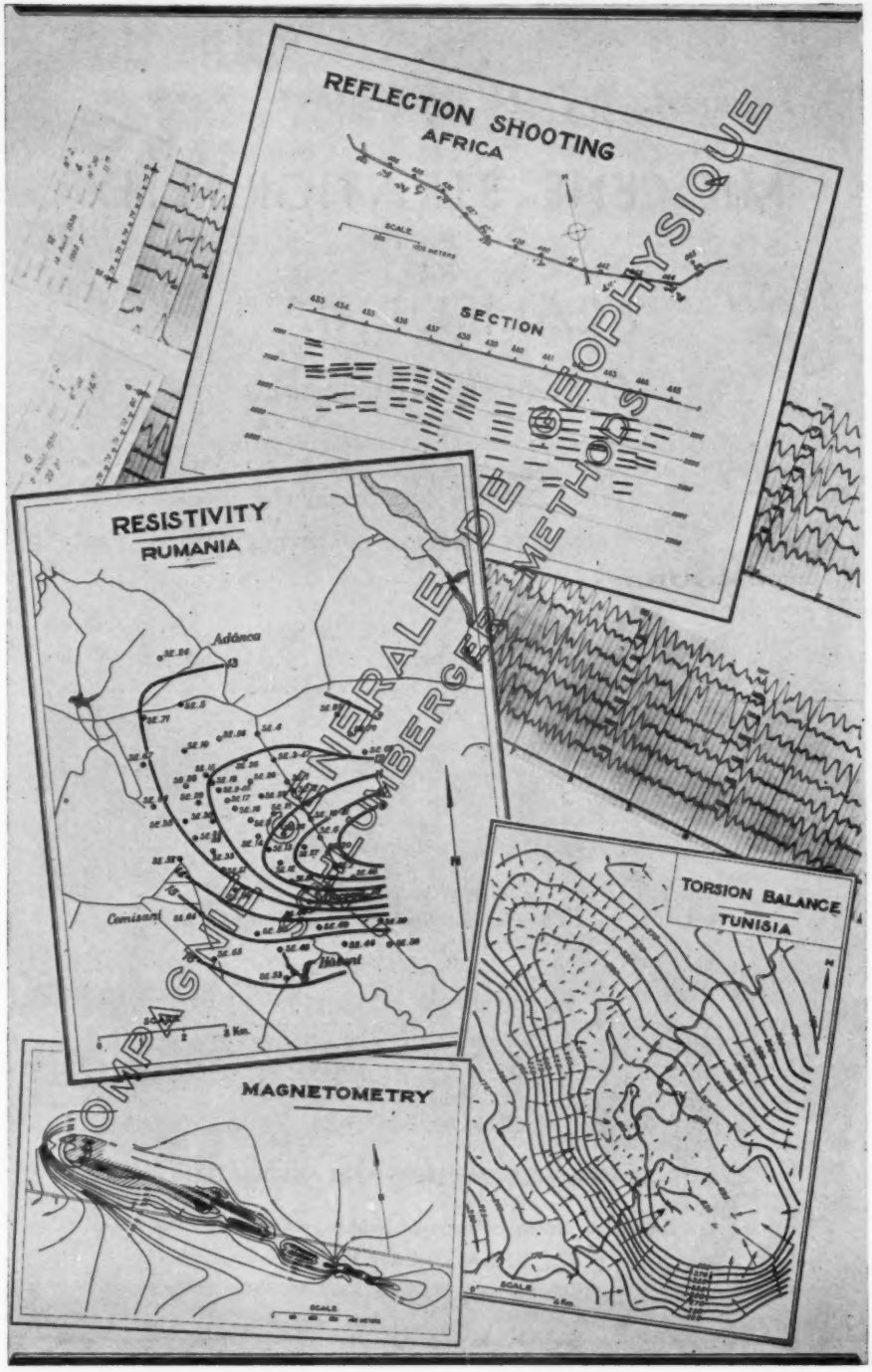
SCHLUMBERGER ELECTRICAL PROSPECTING METHODS

2720 Leeland Avenue, HOUSTON, TEXAS

Agents in

NEW YORK, LOS ANGELES, SEATTLE, MARACAIBO, CARACAS,
COMODORO RIVADAVIA, SANTIAGO, SAN FERNANDO, BOGOTA
SAO PAULO, MEXICO, KHODAUNG, DIGBOI, PLADJOE, RABAT,
PLOESTI, LWOW, BUDAPEST, TOKIO, ANKARA, HANNOVER, VIENNA

Patents all over the world


REFLECTION SHOOTING
AFRICA
SECTION
RESISTIVITY
RUMANIA
Adânca
Comisani
Hohoni
TORSION BALANCE
TUNISIA
MAGNETOMETRY
COMPAGNIE GÉNÉRALE DE GÉOPHYSIQUE
SCHLUMBERGER METHODS

A new A. A. P. G. book

MIOCENE STRATIGRAPHY OF CALIFORNIA

By ROBERT M. KLEINPELL

This Work Establishes a Standard Chronologic-Biostratigraphic Section for the Miocene of California and Compares It with the Typical Stratigraphic Sequence of the Tertiary of Europe

CONDENSED TABLE OF CONTENTS

	Page
Introduction and Scope	1
The Reliz Canyon Section	7
General Stratigraphy	7
The Foraminifera	9
Paleogeographic Significance of the Foraminiferal Assemblages	11
Correlation and Age	20
Historical Summary of Foraminiferal Data	20
Analysis of Stratigraphic Distribution of Foraminifera in the California "Miocene"	79
Chronologic-Biostratigraphic Classification of the Marine Middle Tertiary ("Miocene") of California	87
Formational Correlations Within the California Province	159
Stratigraphic Position of Reliz Canyon Section with Respect to California Middle Tertiary Stage Sequence	159
Stratigraphic Position of Some Typical California Formations with Respect to Middle Tertiary Stage Sequence	160
Age of California Stage Sequence with Respect to European Tertiary Column	168
Systematic Catalogue	182
Index	357

400+ pages; 14 line drawings, including a large correlation chart in pocket; 22 full-tone plates of Foraminifera; 18 tables (check lists, and a range chart of 15 pages) Bound in blue cloth; gold stamped; paper jacket; 6x9 inches.

PRICE: $5.00, POSTPAID

($4.50 TO A.A.P.G. MEMBERS AND ASSOCIATES)

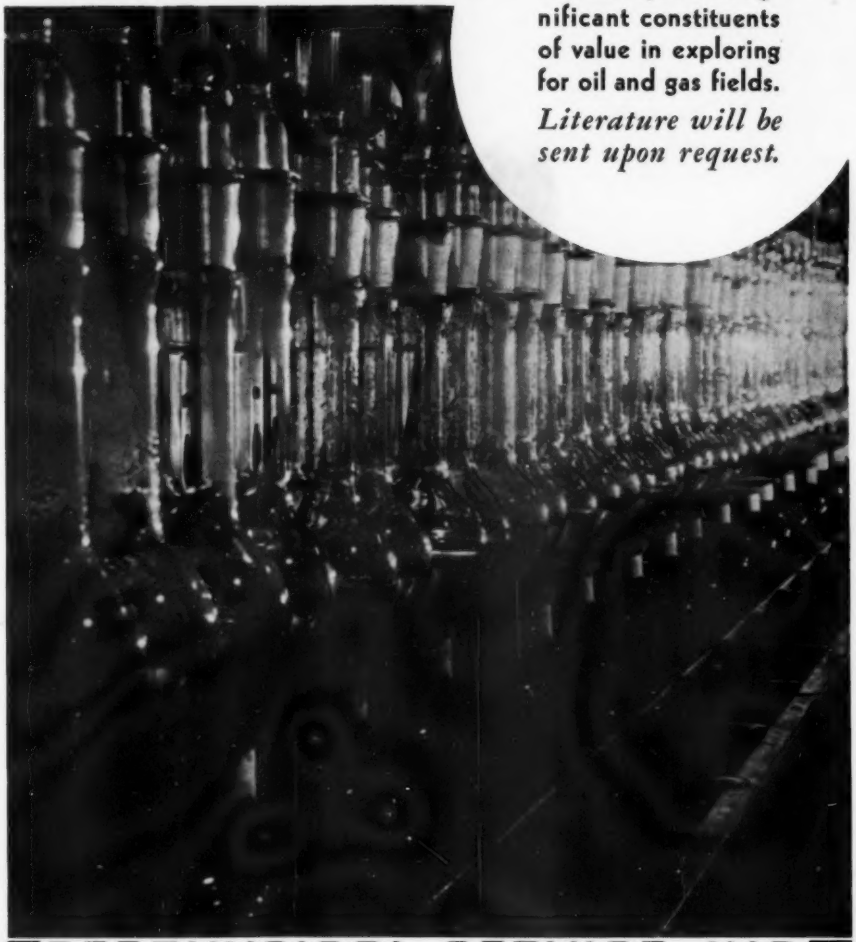
The American Association of Petroleum Geologists
BOX 979, TULSA, OKLAHOMA, U.S.A.
London: Thomas Murby & Co., 1, Fleet Lane, E.C. 4

SOIL SURVEYS

A DIRECT EXPLORATION METHOD

Soil Surveys for all significant constituents of value in exploring for oil and gas fields.

Literature will be sent upon request.



GEOPHYSICAL SERVICE INC

EUGENE McDERMOTT
PRESIDENT

H. B. PEACOCK
VICE PRESIDENT

J. E. JONSSON
SECRETARY - TREASURER

DALLAS, TEXAS

When you need a

CORE

You Get it . . with a HUGHES CORE BIT !

In drilling deep wells, there comes a time when a large, unbroken, uncontaminated core must be had. Then is when it pays to send down a Hughes conventional Core Bit . . . and "know" when you come out you will have the kind of core you want.

Hard and soft formation cutter heads are interchangeable for varying formations.

HUGHES TOOL CO.
HOUSTON, TEXAS